TECHNICAL MEMORANDUM 1

REVISIONS TO FINAL

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

WALNUT CREEK PRIORITY DRAINAGE
(Operable Unit No. 6)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

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INTRODUCTION

Technical Memorandum 1 (TM1) has been prepared in order to address comments submitted by the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) on the Operable Unit No. 6 (OU 6) Final Phase I RFI/RI Work Plan. Because most of the comments address the Site Conceptual Model (Section 2.11) and the Field Sampling Plan (Section 7), these sections have been revised pursuant to EPA and CDH comments and are included in TM1 (all revisions made to Section 7 are shaded; Section 2.11 has been revised in its entirety). The Final Work Plan together with TM1 represent RFI/RI planning documents for OU 6 that are consistent with the Inter-Agency (IAG) Statement of Work (SOW) for the Phase I investigation. TM1 provides the link between the Site Conceptual Model and the Field Sampling Plan to demonstrate that all potential exposure pathways were considered in the development of the work plan.

The characterization of all exposure pathways will not be performed for every IHSS within OU 6 during Phase I. The Phase I characterization plan is designed to collect sufficient data at each IHSS to satisfy exposure pathway characterization needs commensurate with the likelihood that a contaminant source exists. For example, at the Triangle Area (a probable source of contamination), the characterization program is more extensive and data collected for other IHSSs and for determining the overall extent of contamination within the Walnut Creek drainages may allow characterization of most exposure pathways. In contrast, at the East Area Spray Field where the existence of a contamination source is less likely because of the limited time of use, sampling to simply verify the presence or absence of contamination in surface and subsurface soils is a logical size for a Phase I program. In either case, a Phase II RFI/RI may be required to better characterize a contaminant source or exposure pathway depending upon the Phase I results.

There were a few comments that are not specifically addressed by the revisions to the Site Conceptual Model and the Field Sampling Plan. These comments are addressed below:

U.S. ENVIRONMENTAL PROTECTION AGENCY COMMENTS

<u>EPA General Comment, Air Monitoring Citation E-1.4:</u> Analytical data for surface water, groundwater, and sediments are summarized in a table in the appendices of Volume II of the final work plan. However, historical air monitoring data were not included even though this medium is also considered to be a potential exposure pathway. The response offered simply makes reference to the sitewide ambient air monitoring program, which is severely limited in extent and purpose and is not considered adequate to support decision making in this OU.

Response: Historical air quality data has been summarized and is included as Attachment 1 to TM1.

EPA General Comment, Phase I vs. Phase II, Citation E-1.2: The argument presented in response to our position on the appropriate scope of Phase I efforts is incorrect. Due to unilateral changes made in the field sampling plan since the draft version was reviewed, the requirements of IAG Table 5, as modified during scoping meetings, are no longer met. Further, blind adherence to these requirements does not justify a plan which fails to adequately address important potential exposure pathways.

Response: This has been addressed in the Introduction (Section 1.0) and by revisions made to the Conceptual Model (Section 2.11) and the Field Sampling Plan (Section 7.0)

EPA Comment on Section 2.11, Site Conceptual Models, Citation E-11: DOE's response to EPA comments noting the incomplete nature of the site conceptual models was to provide a "generic model". This "model" does not address the elements of a complete exposure pathway (i.e., source, release mechanism, transport media, exposure point, exposure route, and receptor), and is so sketchy and superficial it is virtually useless. This is an inadequate response, and the failure of DOE to develop a complete conceptual model has resulted in a deficient RFI/RI plan. We believe formulation of accurate conceptual models is an integral part of the development of RFI/RI Workplans. The information obtained through implementation of a work plan developed in accordance with a proposed conceptual model is critical not only to ascertaining the accuracy of the conceptual model is critical not only to ascertaining the accuracy of the conceptual model but to understanding the nature and extent of contamination and to determining the need for a Phase II investigation.

Response: The Conceptual Model (Section 2.11) has been revised in its entirety and is included as part of TM1.

COLORADO DEPARTMENT OF HEALTH COMMENTS

Citation C-3: The Division remains concerned that the vadose zone will not be properly addressed through the execution of this work plan. The Division cannot recall, and has not found, any specific discussion of the vadose or unsaturated zone. The "vadose zone sampling ... provided for in the FSP" is more circumstantial than planned. The vadose zone sampling the Division envisions goes beyond that provided by SOPs GT.2 and FO.16 to embrace the collection of gas and liquid samples as proposed in the approved OU-7 work plan, i.e. the BAT sampler. This is not to suggest that every borehole at every IHSS is lacking this approach. Only those sites where the types of contaminants, the waste management practice, and the duration of that practice, may have fostered movement of contaminants into or through the vadose zone are at issue. These specifically are: the North, South and Pond Area Spray Fields, Soil Dump Area, Triangle Area and Trenches A, B and C. The remaining IHSSs are of lesser concern pending FSP results.

Response to C-3: Vadose zone sampling is a useful technique for detecting early releases from landfills or surface impoundments where direct sampling is not possible. There are known problems with vadose zone sampling reliability, representativeness and repeatability. Soil borings and monitoring wells will be placed directly into potentially contaminated zones beneath the Spray Fields, Trenches, Soil Dump Area and the Triangle Area. These samples will provide a more direct and vertically complete picture of the zones of contamination than is possible with a vadose zone sampler. However, locations may be encountered where contamination is found in zones where there is no saturated zone above bedrock. In this case, if contamination beneath an IHSS extends to significant depths, this would indicate contaminant migration via unsaturated flow may be a significant pathway, and a vadose zone sampler (e.g. a BAT) may be appropriate.

Citation C-4: Please refer to the Division's letter of September 19, 1991, entitled "Phase I and Phase II RFI/RI Workplans and Investigations". The position of the Division and EPA concerning the need for comprehensive assessment of nature and extent of contamination, as an integral part of this work plan, is therein supported.

Response to C-4: As discussed above in the introduction, a complete characterization of all exposure pathways during the Phase I investigation may not be accomplished for every IHSS within OU 6. However, at all IHSSs within OU 6, sediments, surface waters, surface soils, subsurface soils and bedrock are being studied to varying extents depending on the likelihood that significant contamination is present. In any case, a Phase II RFI/RI may be necessary to further characterize a pathway or source pending the Phase I findings. For example, additional alluvial wells may be needed to characterize groundwater contamination at an IHSS during Phase II. It would not be cost effective to install numerous wells in Phase I without prior knowledge of an alluvial groundwater contamination problem.

Citation C-40: DOE's attempt to resolve the significance of Trenches A, B and C to the Rocky Flats Alluvium is inadequate. The alluvium is not "near" or "in the area of" the trenches. The trenches were dug into or through the alluvium. This is a fact; state the fact. Why is it so difficult to say: The aquifer in, or through, which the trenches were dug is the Rocky Flats Alluvium. The potential for contamination of this aquifer shall not be diminished by a resourceful choice of words.

Response to C-40: DOE recognizes that the trenches were likely excavated in the Rocky Flats Alluvium. Section 2.6.5 of the Final Phase I RFI/RI Work Plan states "Approximately 1.5 feet of topsoil has developed on the Rocky Flats Alluvium at IHSS 166.1 and may be present in the vicinity of Trench B and C. Rocky Flats Alluvium is found beneath the topsoil and has a thickness of about 6 feet in this area."

Citation C-49: Modification of the conceptual models to a generic version was a poor choice. Specific conceptual models should be used to drive the FSP to adequately address the data needs for risk assessment and nature and extent of contamination. Not only has DOE responded that this work plan is not intended to address nature and extent, but the simplification of the conceptual model has assured that even the risk assessment data requirements are not fully addressed.

Response to C-49: This comment is addressed by the revision of Section 2.11, Conceptual Models.

Citation C-72: The Division acknowledges that the chemical parameters Benzene, Phenol, etc. were listed as Parameters on the original Table 3-3 and appreciates that numerical standards, previously omitted, have now been included.

Response to C-72: No response required.

Citation C-87: It appears from DOE's response that the comment is not understood. The Division is concerned that false negatives on soil gas surveys may lead DOE to scrap boreholes/wells that may detect contaminants in vadose or ground water. "Checks" on screening techniques are essential to diminish the potential for "missing" contaminants.

Response to C-87: In the revised Section 7.0, surface and subsurface soil samples will be collected regardless of the screening results, to test for false negatives.

Citation C-87: The Division rejects DOE's assertion that "it is premature to speculate on what the possible result of the Phase I investigation will be." Although the result of the Phase I investigation as a whole may be complex, it remains that the results from sampling and analysis efforts on an IHSS by IHSS and sample technique by sample technique basis can be used to decide on a next level of effort of, if warranted, no additional effort. For example, if soil borings indicate contamination is moving into vadose water, then sampling with the BAT instrument (see OU-7 work plan) would be indicated. If soil borings found nothing of consequence then vadose sampling could be omitted. Also, see the Division's comment to DOE's response to Citation C-4.

Response to C-89: The Field Sampling Plan has been modified to be more comprehensive in terms of addressing all the potential pathways and all contaminants that may migrate through those exposure pathways. Phase II efforts cannot be defined until the magnitude of the contamination is better addressed. The response to Citation C-3 discusses the vadose zone sampling.

Citation C-92: The Division's comment, C-108, concurred that the planned borings were adequate to define the type and level of contamination. DOE should not infer that a hole bored two feet below the original surface of the Old Outfall would characterize stratigraphy. Please refer to a geologic dictionary; stratigraphy is defined quite differently than lithology. The planned boreholes should provide a glimpse of the lithology but will not penetrate bedrock strata to a depth sufficient to define geologic succession.

Response to C-92: DOE concurs and recognizes the difference between stratigraphy and lithology as discussed in Section 5.5.1.

Citation C-94: Please see the Division's comment to DOE's response to Citation C-4.

Response to C-94: A discussion of the difference in scope between Phase I and Phase II investigations is discussed in the first part of this introduction. No additional response is required.

Citation C-107: DOE has not replied to why additional sediment sampling sites were not proposed for the downstream portion of the unnamed tributary. The Division has stated that older data may not be useable. DOE responded by eliminating many of the proposed North and South Walnut Creek sediment sample sites without any indication as to the useability of older data. DOE should return to the earlier proposal or demonstrate that the older data have been validated and that they are sufficient in quantity. (Relocating one of the sediment sampling sites downstream of the South Area Spray Field is acceptable.)

Response to C-107: Monitoring of the downstream portion of the unnamed tributary to Walnut Creek is covered by the site wide sampling stations SED - 06, 07, and 035 (Figure 7-4 p. 2 of 2). In addition, investigations for OU 7 will cover the downstream portions of this tributary and the pond near the present landfill. The historical data that is available for this location will be used if it is validated.

Citation C-108: Steps 1 and 2 of Section 7.2.3 still discuss radiation surveying and soil sampling of the existing surface. Although Table 5 specified this sampling effort, the Division believes that it can be scaled back or eliminated. If it is DOE's intent to perform this work due to the unknown origin of the fill, the effort may have merit.

Step 3 will provide data from the pre-existing surface; however, the location of the boreholes as depicted on Figure 7-5 are misleading. A review of Figure 2-14 clearly shows that proposed boreholes along the east boundary (and others) will not target suspected areas of contamination. Figure 2-14, therefore, should be used as a base to select borehole locations, not Figure 7-5.

Response to C-108: This concern is addressed in Section 7.2.3 text revisions and revisions to Table 7-4. DOE concurs that the location of the boreholes as depicted on Figure 7-5 are inaccurate. Figure 7-5 has been revised to incorporate the details shown on Figure 2-14 so that the borehole locations will target suspected areas of contamination.

Citation C-112: It is correct that the IAG, Table 5, specified the collection of samples "around the perimeter" of this unit; however, DOE's interpretation that this excluded sampling of the waste piles is incorrect. Clearly, the piles are intended to be the focus of the investigation.

The issue is whether reducing the sample grid from 50 feet to 150 feet is appropriate. DOE still has not defined the type of grid used (see C-96 of the Document Review Comment Record); therefore, the Division assumes it is a mesh-centered grid and recommends to EPA that a 75' mesh-centered grid be imposed. This would result in an approximate 50% reduction in sample coverage based on the IAGs 50' grid requirement.

Response to C-112: These concerns are addressed in the revisions to Section 7. The waste piles will be sampled as identified in Figure 7-1. Depending upon the sampling results, additional borings may be placed in this area.

Section 2.11: The disposition of Division comment C-49 states that "All of the conceptual models have been modified to present a generic conceptual model showing all pathways of exposure for all of the IHSS's." Site conceptual models should be used to assist in identifying sampling needs to obtain information for evaluating risks to human health. The conceptual models presented in the work plan cannot effectively identify sampling needs.

Each individual IHSS in OU-6 has a history of waste management practice (spraying, dumping, burial), suspected types of contaminants (radionuclides, metals, VOCs), and physical setting (geology, topography, hydrology) that help define expected or probable exposure pathways. When this information is used to conceptualize how exposure may occur, it is then possible to rationally define the types of samples, screening techniques and analysis requirements that will determine contaminant concentrations along each pathway. Without an analysis of the pathways, it is reasonable to suspect that data needs will not be fully addressed.

The Division has conducted a preliminary analysis of pathways and has identified gaps in the data needed for risk assessment. DOE must not miss this opportunity to collect all relevant data. Therefore, a conceptual model, comparable to that developed for the OU-3 work plan, should be prepared.

Following is a list of additional samples (and where appropriate analyses) that must be collected to fulfill data needs, others may be identified through a more rigorous pathways analysis. Please refer to the attached copy of Table 7-11 which summarizes additions proposed by the Division.

Response to Section 2.11: These concerns are addressed in the revisions to Section 2.11 and Section 7. Specific sampling concerns are addressed in Tables 2-22 through 2-28 and revisions to Tables 7-1 through Table 7-9. Specific analytical concerns are addressed in revisions to Table 7-11.

2.11 SITE CONCEPTUAL MODELS

A Site Conceptual Model of contaminant exposure pathways from the types of potential contaminant sources within OU 6 is presented in this section. This Site Conceptual Model identifies all elements of an exposure pathway (contaminant source, primary release mechanisms, transport media, secondary release mechanisms, and exposure route) that were considered in the development of the Phase I Field Sampling Plan. After Phase I data is collected, IHSS-specific conceptual models can be developed and provide the basis for Phase II RFI/RI activities and the Baseline Risk Assessment.

The primary purpose of the Site Conceptual Model is to aid in identifying exposure pathways by which populations may be exposed to contaminants from the IHSSs. The EPA defines an exposure pathway as "...a unique mechanism by which a population may be exposed to the chemicals at or originating from the site..." (EPA, 1989c). As shown in Figure 2-15, an exposure pathway must include a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor. An exposure pathway is not complete without each of these five components. The individual components of the exposure pathway are defined as follows:

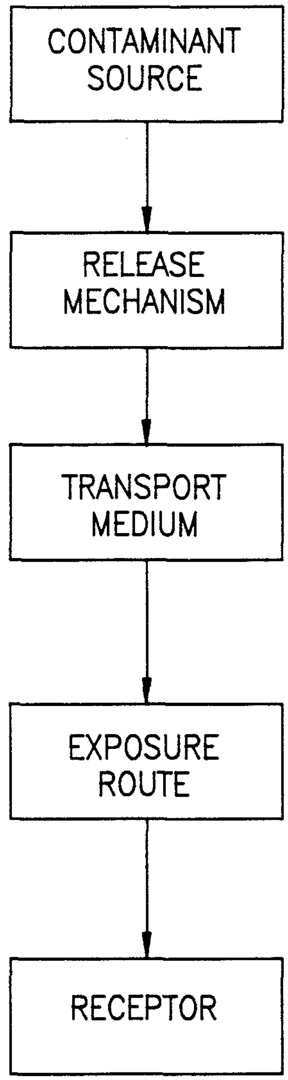
- **Contaminant Source:** For the purposes of the OU 6 conceptual model, the contaminant sources are waste and/or contaminated media that may be present at each IHSS. These sources include buried wastes, and contaminated surface soils and sediments.

- **Release Mechanism:** Release mechanisms are physical and/or chemical processes by which contaminants are released from the source. The conceptual model for OU 6 identifies mechanisms which release contaminants directly from the source and those which release contaminants from transport media (i.e., secondary release mechanisms). Numerous potential release mechanisms and secondary release mechanisms for OU 6 are discussed in the conceptual model.

- **Transport Medium:** Transport media are the environmental media into which contaminants are released from the source and from which the contaminants are in turn released to a receptor (or to another transport medium by a secondary release mechanism). Potential transport media for OU 6 include, air, soils, sediment, surface water, groundwater, and biota (both flora and fauna).

- **Exposure Route:** Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU 6 are inhalation, ingestion, dermal contact, and external exposure to radiation from radionuclides.

- **Receptor:** Receptors are human or environmental populations which are affected by the contamination released from a site. Environmental receptors include biota (both flora and fauna) indigenous to the OU 6 environs.



R33159.PJ-120991

U.S. DEPARTMENT OF ENERGY Rocky Flats Plant Golden, Colorado	COMPONENTS OF A COMPLETED EXPOSURE PATHWAY	FIGURE 2-15

2.11.1 Contaminant Source Descriptions

2.11.1.1 A and B Series Detention Ponds (IHSS 142.1 - 142.4 and 142.5-142.9)

The detention ponds along Walnut Creek drainage are used primarily to capture and control surface water runoff. Historically, water and sediment samples from these ponds have occasionally contained low concentrations of radionuclides, metals and organic compounds. These contaminants, however have primarily been found in the bottom sediments of the ponds. The ponds are used to capture and control surface runoff from the northern part of the Rocky Flats production facilities, Various discharges that contained nitrates and radioactive substances, including plutonium and uranium, along with laundry wastes containing plutonium, flowed into the Walnut Creek drainage.

2.11.1.2 North, Pond, South Area and East Area Spray Fields (IHSS 167.1-167.3 and 216.1)

The spray fields (IHSS 167.1 - 167.3 and 216.1) were used to spray and evaporate the water that collected in the East and West Landfill Ponds and water in Pond B-3. Excessive runoff caused spraying to be stopped at the North and South Spray Fields. Limited chemical data are available and are described in subsection 2.4.4. Contaminated spray water may have contaminated the surface soils on the spray field areas. Groundwater underneath the spray may also be contaminated from infiltration of spray contaminants.

2.11.1.3 Trenches A, B and C (IHSS 166.1 - 166.3)

The Trenches were storage areas for contaminated soils and sludges. The sludges and soils are all believed to have contained low levels of uranium/and or plutonium. The area has not been well characterized in terms of site contaminants.

2.11.1.4 Sludge Dispersal Area (IHSS 141)

The Sludge Dispersal Area was a storage area for contaminated sludges. The sludges are believed to have contained low levels of uranium/and or plutonium. The area has not been well characterized in terms of site contaminants.

2.11.1.5 Triangle Area (IHSS 165)

The Triangle Area (IHSS 165) was used as a storage site for miscellaneous wastes, including 55-gallon drums containing plutonium-contaminated wastes, between 1966 and 1975. Drum leaks were detected on several occasions followed by several cleanup activities. There is currently a 6 inch thick cover of clean material over the area. At present there is no waste storage in the Triangle area but there is storage of equipment.

2.11.1.6 Old Outfall (IHSS 143)

The Old Outfall received process and or/laundry wastes between the 1950's and the 1970's including plutonium wastes and analytical and radiography wastes. The area was remediated for radioactive contamination in the soil in 1972 and has since been covered with 8-10 feet of clean fill. There is still a surface water drainage and a culvert running through the Old Outfall and contaminants were found historically at the edge of the Old Outfall drainage.

2.11.1.7 Soil Dump Area (IHSS 156.2)

The Soil Dump Area was a storage area for contaminated soils. The soils are believed to have contained low levels of uranium and/or plutonium. The Soil Dump area also contains asphalt debris and concrete remains. This area has not been well characterized in terms of site contaminants.

2.11.2 Primary Release Mechanisms and Transport Media

There are a number of mechanisms by which contaminants are released into environmental media. As shown in Figures 2-16 and 2-17, all primary release mechanisms apply to contaminated surface soils and sediment: fugitive dust wind erosion; surface runoff; volatilization; infiltration/percolation; biotic uptake; and tracking. With the exception of fugitive dust wind erosion, surface runoff and biotic uptake, these primary uptake mechanisms also apply to buried wastes.

Once contaminants are released from a source, they will enter an environmental medium where contaminants will be transported either to a point of exposure or be released (secondary release mechanism) to another environmental medium (and subsequently transported to a point of exposure). The transport medium a contaminant enters is determined by the primary release mechanism. For example, volatilization or fugitive dust wind erosion will result in contaminant release to the air. Surface runoff will transport contaminants to surface water while infiltration/percolation results in contaminant transport to ground water. Contaminants entering biota is simply due to biotic uptake.

The physical and chemical properties of a contaminant determine the tendency of a contaminant to be released from a source, and the fate and mobility in a transport medium once released. The following subsections provide a brief summary of these contaminant properties.

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

RISK ASSESSMENT
CONCEPTUAL MODEL

FIGURE 2-16

December, 1991

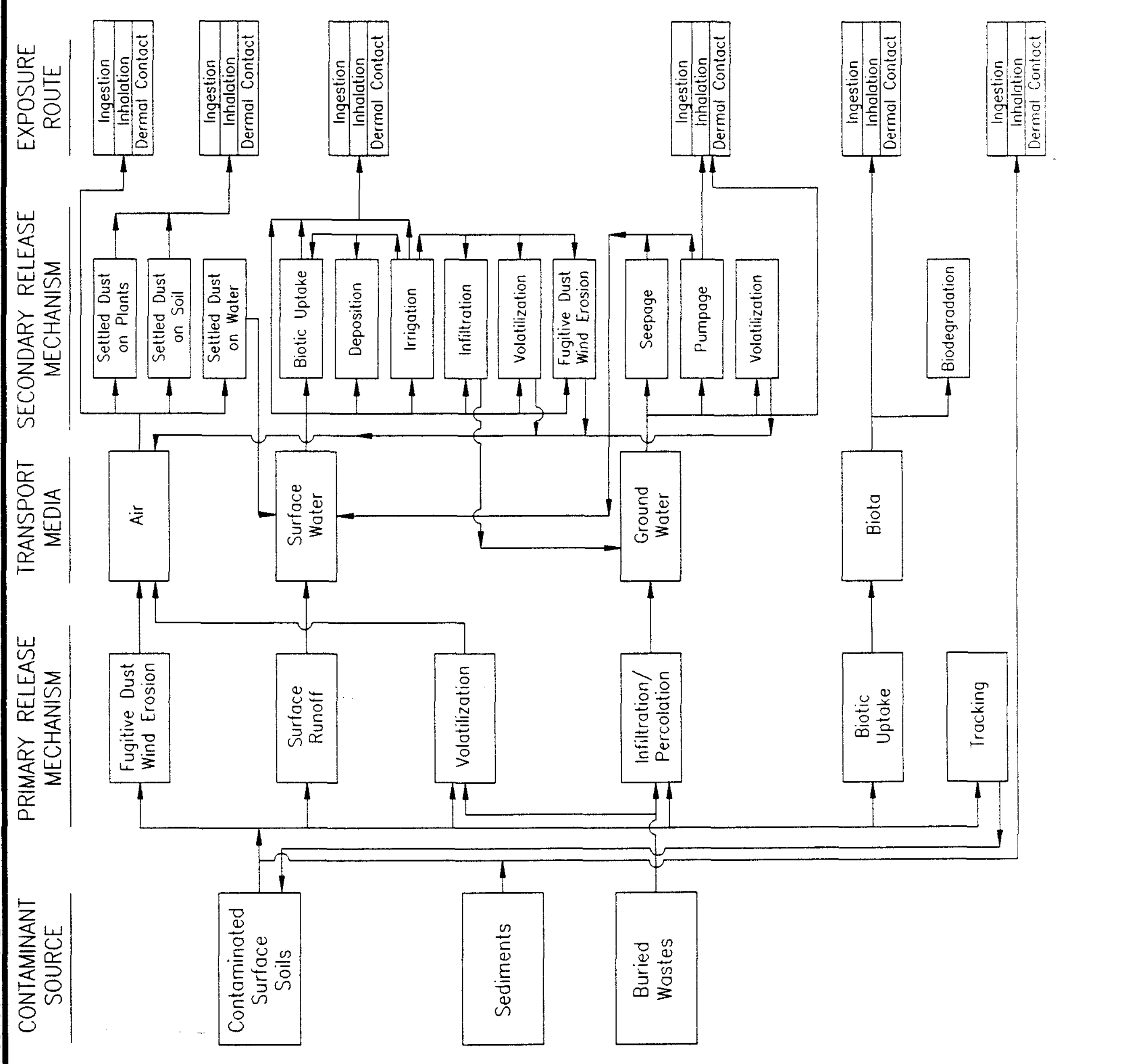


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Figure 2-17

2.11.2.1 Organic Contaminants

Table 2-18 presents some of the relevant chemical/physical parameters that control the environmental fate and transport of representative organic chemicals. Because several IHSSs at OU 6 accepted a wide range of materials, further investigation may identify additional organic chemicals not present on this list.

TCL Volatiles

TCL volatiles are generally more mobile in the environment than other chemicals (Table 2-18). Volatiles are generally characterized by relatively high water solubility (greater than 100 mg/l) and volatility (vapor pressures greater than 1.0 mm Hg and Henry's Law Constants greater than 0.1). Volatiles can be expected to migrate through soils, sediment and groundwater in both liquid and vapor phase and to be transported in surface water and groundwater as neutral solutes. This is denoted by retardation factors (Rd) between 1 and 50 (Chemical migration velocity = water migration velocity/Rd). The Henry's Constants of volatiles suggest a tendency to volatilize from aqueous systems (including soil/water) to the atmosphere and, therefore, are unlikely to be detected in sediments and soils.

TCL Semivolatiles and Pesticides/PCBs

Semivolatile compounds and pesticides/PCBs typically are much less mobile than volatile compounds (Table 2-18). The retardation factors for semivolatiles and pesticides/PCBs range from approximately 100 to over 180,000,000 with the exception of the phenolic compounds. Phenols are relatively mobile because of their high water solubility. Semivolatiles and pesticides/PCBs exhibit low to negligible volatility as indicated by the low vapor pressures and Henry's Constants. This suggest a low propensity for volatilization of these compounds to the atmosphere from soil and surface water.

2.11.2.2 Radionuclides and Metals

Table 2-19 summarizes the distribution coefficients for radionuclides and inorganic elements. A distribution coefficient (K_d) is the ratio of the concentration of a compound in the solid phase to its concentration in solution at equilibrium. The distribution coefficients are considered empirical and are strongly influenced by the environmental conditions existing where the experiments are performed. Inorganic compounds differ from organic compounds in that they can be present in solution in a number of different forms or species. The form of an inorganic chemical is important in evaluating that chemical's mobility. Each species or complex may have different solubilities and the concentration of each can be related to several factors including pH and oxidation/reduction potential (E_h).

TABLE 2-18

CHEMICAL/PHYSICAL PARAMETERS AFFECTING ENVIRONMENTAL FATE AND TRANSPORT FOR ORGANICS

Chemical	Molecular Weight (g/mole)	Specific Gravity (g/cc)	Vapor Pressure (mmHg)	Henry's Constant (Dimensionless)	Water Solubility (mg/l)	Log Kow (c/c)	Log Koc (ml/g)	Saturated Zone Rd	Mobility Index MI	Env. Mobility
TCL VOLATILE ORGANICS										
Ketones & Aldehydes Acetone	55.1	0.1	270.00	0.013	60000.0	-0.24	-0.43	1.0	8	Extremely Mobile
Monocyclic Aromatics										
Benzene	78.1	0.9	76.00	0.182	1780.0	2.13	1.81	6.8	3	Very Mobile
Toluene	92.1	0.9	22.00	0.214	515.0	2.79	2.48	28.0	2	Very Mobile
Ethyl Benzene	106.2	0.9	7	0.266	152.0	3.34	3.04	100.0	-0	Slightly Mobile
Xylene	106.2	0.9	10	0.380	152.0	3.13	2.11	12.6	1	Very Mobile
Chlorinated Aliphatics										
Carbon Tetrachloride	153.8	1.6	90.00	0.960	785.0	2.96	2.64	40.5	2	Very Mobile
Trichloroethene	131.4	1.5	60.00	0.390	1100.0	2.42	2.10	12.3	3	Very Mobile
Chloroform	119.4	1.5	160.00	0.130	8000.0	1.97	1.64	4.9	4	Very Mobile
1,1,1,2-Trichloroethane	167.9	1.6	5.00	0.016	2900.0	2.39	2.07	11.6	2	Very Mobile
SEMIVOLATILE ORGANICS										
Acid Extractables (Phenolics)										
Phenol	94.1	1.1	0.20	1.2E-04	8200.0	1.46	1.15	2.3	2	Very Mobile
Pentachlorophenol	266.4	2.0	1.1E-0	1.1E-04	14.0	5.18	4.72	4771.3	-8	Immobile
2,4-Dinitrophenol	184.1	1.7	1.5E-05	2.7E-08	5600.0	1.54	1.22	2.5	-2	Slightly Immobile
2,4,6-Trichlorophenol	197.5	1.5	0.012	1.6E-04	800.0	3.61	3.30	181.0	-2	Slightly Immobile
Base-Neutral Extractables										
Bis(2-ethylhexyl)phthalate	391.1	1.0	2.7E-07	4.4E-06	1.3	9.61	9.30	1.8E+08	-16	Very Immobile
Chrysene	228.2	1.3	1.0E-11	6.9E-08	0.0	5.61	5.30	1.8E+04	-19	Very Immobile
1,2,4-Trichlorobenzene	181.5	1.5	0.29	9.6E-02	30	4.28	3.96	8.3E+02	-3	Slightly Immobile
1,3-Dichlorobenzene	147.0	1.3	2.28	1.5E-01	123	4.28	3.96	8.3E+02	-2	Slightly Immobile
Naphthalene	128.2	1.0	0.087	1.9E-02	31.7	3.29	2.97	8.6E+01	-3	Sightly Immobile
Benzo(a)pyrene	252.0	1.4	5.6E-09	2.0E-05	3.8E-03	6.06	6.74	5.0E+05	-17	Very Immobile

eg&g\ou6\tbl-2-18

TABLE 2-18

CHEMICAL/PHYSICAL PARAMETERS AFFECTING
ENVIRONMENTAL FATE AND TRANSPORT
FOR INORGANICS
(Concluded)

Chemical	Molecular Weight (g/mole)	Specific Gravity (g/cc)	Vapor Pressure (mmHg)	Henry's Constant (Dimensionless)	Water Solubility (mg/l)	Log Kow (c/c)	Log Koc (ml/g)	Saturated Zone Rd	Mobility Index MI	Env. Mobility
PCBs AND PESTICIDES										
PCBs										
PCB-1248	299.5	1.4	4.9E-04	1.5E-01	0.054	5.76	5.44	24931.0	-10	Immobile
PCB-1254	328.4	1.5	7.7E-05	4.6E-02	0.0	6.03	5.72	47233.7	-11	Very Immobile
PCB-1260	375.7	1.6	4.1E-05	2.8E-01	0.0	7.15	6.82	594625.1	-14	Very Immobile
Chlorinated Pesticides										
Dieldrin	381.0	1.8	1.8E-07	1.9E-05	0.2	3.54	3.23	153.8	-11	Very Immobile
DDT	375.7	1.6	1.9E-07	7.1E-04	5.5E-03	6.91	6.59	350141.6	-16	Very Immobile
Heptachlor	375.0	1.6	3.0E-04	3.4E-02	0.18	4.4	4.1	1081.0	-8	Immobile
Lindane	291.0	1.6	2.5E-05	2.5E-04	1.6	3.9	3.6	343.0	-8	Immobile
Chlordane	409.8	1.6	1.0E-05	4.0E-03	0.056	5.5	5.1	12601.0	-11	Very Immobile
Toxaphene	414.0	1.6	0.3	1.4E+01	0.5	3.3	3.0	87.8	-4	

Source: EG&G, 1990e

eg&g\ou6\tbl-2-18

Radionuclides

The limited data available for OU 6 indicates that depleted uranium and plutonium contaminated wastes may be present. Americium is also likely to occur either from *in situ* ingrowth from the plutonium or from direct disposal of americium contaminated material.

The following discussions focus on characteristics of uranium and plutonium which may affect their fate and mobility in the environment (Table 2-19). Numerous studies of uranium and plutonium fate and mobility are incorporated by reference into the discussions. Much less information is available on the nature of americium in the environment. Americium has essentially the same characteristics in the environment as plutonium and is considered insoluble under typical environmental conditions.

Uranium

Uranium has 14 isotopes that decay to other elements at half-lives of minutes to 4.5 billion years. Natural uranium is comprised mainly of U-238 (99.27 percent) with some U-235 (0.72 percent) and minor amounts of U-234 (0.0057 percent) (Table 2-20). Enriched uranium contains a higher percentage of the fissile U-235 isotope. Depleted uranium, a potential contaminant at OU 6, contains less U-235 and U-234, and more U-238. Uranium-234 is a daughter product of uranium -238.

Thermodynamic data (Langmuir, 1978) indicates that most uranium in natural waters exists in the U(IV) or U(VI) oxidation state. Uranium in both oxidation states exhibits a strong affinity to complex with available anions in natural waters as either uranous (U^{4+}) or uranyl (UO_2^{+2}) ion. Because U(IV) species tend to precipitate as insoluble uraninite or coffinite (Langmuir, 1978), uranyl ion is the mobile species for most oxidizing groundwaters. More importantly, UO_2^{+2} is mobile over a relatively wide pH range. Depending on the ligands available and the pH, uranyl ion will form soluble complexes in oxidizing waters. Thus, uranyl will be soluble and hence mobile in most oxidizing groundwaters that contain common ligands. Oxidizing conditions probably exist in all alluvial/colluvial materials and extend at least into shallow bedrock as indicated by iron-oxidation staining in numerous drill logs. Therefore, uranium migration via surface water and ground water is likely given adequate leaching, and, therefore, uranium should be analyzed when characterizing these transport media.

TABLE 2-19

LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS

Chemical	Representative Value[1]	Summary Range Low	Summary Range Maximum
Radionuclide			
Americium-241	700	0[4]	47,230[1]
Bismuth-214	200		
Cadmium-109	6.5	1.26[1]	50[3]
Cesium-143	850	3.0[4]	300,000[2]
Cesium-137	1,000	1.3[4]	52,000[1]
Cobalt-60	45	0.2[1]	23,624[4]
Lead-212-Bismuth	900	4.5[1]	7,640[1]
Plutonium-238	4,500	0.4[4]	8.7E7[4]
Potassium-40	5.5	2.0[1]	9.0[1]
Radium-288	450	200[1]	467[4]
Strontium-90	35	0.15[1]	4,300[4]
Thorium-228	1,500	5[4]	1E6[4]
Uranium-234	1,500	0[1]	4,400[1]

[1]U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.
[2]U.S. Department of Energy, 1980, Determination of Distribution Coefficients for Plutonium, range of results for a variety of sediments in the Enewetak Lagoon using Lab and Field experiments; Transuranic Elements in the Environment, Technical Information Center.
[3]Couphtrey, P.J. and Thorne, M.C., 1983, Radionuclide Distribution and Transport in Terrestrial and Aquatic Ecosystems, A Compendium of Data.
[4]ACS Symposium Series, 1979, Radioactive Waste in Geologic Storage (Abyssal Red Clay)
Conc=1E3-1E8 mg/atom/ml in 0.68N NaCl Soin Distributed Coefficient for CS pH2.7-8.0 Figure 1; for Cd pH 5.3 Figure 3; for Sr Phy.1-73; for Ba pH 2.6-8.3 Figure 2; for Ce pH 5.8-8.0 Figure 4.

TABLE 2-19

LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS
(Continued)

Chemical	Representative Value[1]	Summary Range Low	Summary Range Maximum
Metals			
Aluminum	1,500	0[4]	122.8[4]
Antimony	45	1.0[5]	18[5]
Arsenic	200	5[4]	30,000[4]
Barium	60		
Beryllium	650		
Boron	3	1.26[1]	50[4]
Cadmium	6.5		
Chromium	850	0.2[1]	3,800[1]
Cobalt	45	1.4[1]	333[1]
Copper	35	4.5[1]	7,640[1]
Lead	900	0.2[1]	10,000[1]
Manganese	65	30[7]	82,800[7]

[1]U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.
[4]Radionuclide Interactions with Soil and Rock Media Volume 1: Processes Influencing Radionuclide Mobility and Retention, Element Chemistry and Geochemistry, Conclusions and Evaluation, Battelle Pacific Northwest Labs, Richland, WA EPA No. 6078-007, August 1978.
[5]Dragun, 1988, The Soil Chemistry of Hazardous Materials, Dragun, 1988, Ranges of Kd for various Elements in Soils and Clays, Table 4.2, pg 158.

TABLE 2-19

LITERATURE DISTRIBUTION COEFFICIENTS
FOR RADIONUCLIDES AND METALS ELEMENTS
(Continued)

Chemical	Representative Value[1]	Summary Range Low	Summary Range Maximum
Mercury	10	0.37[1]	400[1]
Molybdenum	20	200[7]	300,000[7]
Nickel	150		
Selenium	300		
Silicon	30	10[1]	1,000[1]
Silver	45		
Thallium	1,500		
Titanium	1,000		
Vanadium	1,000		
Zinc	40	0.1[1]	8,000[1]

[1]U.S. Department of Energy, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmental Released Radionuclides through Agriculture.
[7]EPRI, 1984, Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration Volume I. A Critical Review. Battelle Pacific Northwest Laboratories, Richland, WA. EPRI EA-3356, Kd for Ba in River Sediments; Kd for Me= pH=6.6 with Bentonite, Kd-82800 Ph-5.95 for Iron Oxide; Kd=200 for Ni in seawater with Clay pH=8; with Mn Oxide Kd=300,000 pH=8.

TABLE 2-20

ISOTOPIC COMPOSITION OF ROCKY FLATS URANIUM

	Relative Weight (Percent)		Relative Activity[a] (pCi/μg)	
Isotopic	**Natural Uranium**	**Depleted Uranium**	**Natural Uranium**	**Depleted Uranium**
U-232	0	Trace	0	Trace
U-233	0	Trace	0	Trace
U-234	0.0057	0.002	0.35	.124
U-235	0.72	0.3	0.015	.006
U-236	0	0.0003	0	.0002
U-238	99.27	99.7	0.33	.332

[a] Relative activity is obtained by multiplying the percentage by weight by the specific activity.

Uranium has a lower K_d than plutonium or americium (Table 2-19). However, under reducing conditions (such as high-organic, fine-grained, bed sediments deposited in the deeper layers of sediments) uranium is immobilized and becomes part of the sediments.

Yang and Edwards (1984) documented the fate and transport of uranium and its daughter product, radium-226, in dissolved form, and in both suspended and bed sediments, from above the Schwartzwalder (uranium) Mine adjacent to Ralston Creek several miles southwest of the RFP. Uranium is present in dissolved and solid phases. Concentrations range from 4 micrograms per liter ($\mu g/\ell$) dissolved in the creek water above the mine to 100 $\mu g/\ell$ in Ralston reservoir below the mine. Uranium occurred as both a discrete mineral and as partially entrapped colloidal iron and manganese coatings on suspended and bed sediments.

Plutonium

There are 15 known isotopes of plutonium that decay into other elements at half-lives ranging from hours to 387,000 years (Ames and Rai, 1978). At the RFP, plutonium exists primarily as plutonium -239 and -240 (Table 2-21).

Plutonium specification in the environment is heavily influenced by hydrogen ion concentration (pH) and oxidation-reduction capacity (Eh). Typical environmental conditions are pH in the range of 5 to 8 and a positive Eh (greater than 0.05 volts) (Brownlow, 1979). Under these conditions, plutonium species will most likely be found in the following order of occurrence: $Pu^{+4} > PuO_2 > Pu^{+3} > PuO^{+1}$ (Ames and Rai, 1978).

As shown above, the most probable species in the environment is the plus 4 valence (oxidation state) species, which will exist either as plutonium dioxide (PuO_2) or as a solid hydroxide $Pu(OH)_4$ (Brookins, 1984; Dragun, 1988). The assertion is based on the assumption that the pH of the environmental system is near neutral and that the system is in an oxidative state (Eh >0).

Plutonium shows a very strong tendency to adsorb to clays, metal dioxides, and organic matter in soils and thus has a very low migration potential in the environment (CSU, 1974; Brookins, 1984). The distribution coefficient (K_d), for plutonium is 10^3- 10^5 (Allard and Rydberg, 1983), meaning that the ratio of plutonium bound to soil to plutonium dissolved in water would be expected to vary from 1000:1 to 100,000:1. The EPA (1990b) gives a K_d of 2×10^3 for plutonium. At a minimum, analysis of surface water samples should include total plutonium because plutonium may be present in the suspended fraction. Although plutonium is not expected to migrate readily in ground water, its ubiquitous occurrence together with the lack of initial data suggest the Phase I RFI/RI include plutonium analysis for ground water samples.

TABLE 2-21

ISOTOPIC COMPOSITION OF ROCKY FLATS PLUTONIUM

Isotopic	Relative Weight (percent)	Specific Alpha Activity (Curies/gram)	Specific Beta Activity (Curies/gram)	Relative[a] Activity (Curies/gram)
Pu-238	0.01	17.1	--	0.00171
Pu-239	93.79	0.0622	--	0.056834
Pu-240	5.80	0.228	--	0.01322
Pu-241	0.36	—	103.5	0.37260
Pu-242	0.03	0.00393	--	1.18×10^{-6}
Am-241	--[b]	3.42	--	--

Source: Rockwell, 1985b.

[a]Relative activity is obtained by multiplying the percent by weight by the specific activity.

Total activity for the plutonium isotopes is:

Alpha 0.0732 curries/gram
Alpha plus Beta 0.446 curies/gram

[b]Am-241 daughter from decay of Pu-241.

Metals and Major Ions

In general, the solubility of metals and major ions in natural water situations are very sensitive to pH and Eh conditions as are the radionuclides. Based on their physical properties (Table 2-18), they can form complexes and potentially move relatively rapidly within the hydrosphere. There is also a tendency for the ions to be incorporated into new minerals, to be adsorbed on to mineral surfaces, ion exchange or to be coprecipitated. Because initial data on source characterization is limited, the Phase I RFI/RI should include metals analysis in waste, soils, and water.

2.11.3 Secondary Release Mechanisms and Exposure Routes

As shown in Figure 2-16, there are numerous secondary release mechanisms and exposure routes for contaminants that may be released from OU 6 sources. This figure shows all potential pathways; however, the actual pathways of significance will be determined during the risk assessment.

2.11.4 Receptors

The point of exposure includes the source material or any point within a transport media that is contaminated. Whether the human receptor is a resident or visitor there is the potential for direct exposure through multiple pathways. Biota may also be present and be potential receptors. The potential for exposure and the magnitude of risk will be assessed during the risk assessment.

2.11.5 Exposure Pathway Characterization

The elements of the Site Conceptual Model described above are cross referenced to the Field Sampling Plan for characterization details in Tables 2-22 through 2-28 for each IHSS. Site sampling based upon the site conceptual model will improve the characterization of contaminant pathways for each IHSS.
As additional information is obtained, the overall model and specific portion of the model may be refined or expanded to address the issues of concern.

TABLE 2-22

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
A and B SERIES DETENTION PONDS (IHSS 142.1-142.4 and 142.5-142.9)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Sediment Table 7-2, (2-4)	Surface Deposition Table 7-2, (1-4) Table 7-3, (1-11) Volatilization Table 7-2, (1-4) Infiltration Percolation Table 7-2, (5-7) Biotic Uptake Section 9 Tracking Section 9	Groundwater Phase II Biota Section 9 Surface Water Table 7-2,(1-4) Table 7-2,(1-11)	Table 7-2, (1-4) Table 7-3, (1-11) Phase II Infiltration Table 7-2, (5-7) Volatilization Table 7-2, (2-4), 7-3, (1-11) Fugitive Dust Wind Erosion Table 7-2, (2-4), 7-3, (1-11) Sec. 7.2.5 Seepage, Table 7-2,(5-7) Phase II Pumpage Phase II Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-23

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
NORTH, POND, SOUTH AREA AND EAST AREA SPRAY FIELDS (IHSS 167.1 - 167.3 AND 216.1)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Contaminated Soil Table 7-8, (3,4) Table 7-9, (1-2)	Surface Runoff Table 7-8, (5,6) Table 7-9, (1) Volatilization Table 7-8, (3-5) 7-9, (1,2) Infiltration Percolation Table 7-8, (7,8) 7-9, (2) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-8, (7,8) Biota Section 9	Deposition Table 7-8, (3,4) Table 7-9, (1) Irrigation OU 3 Work Plan Infiltration Table 7-8, (7,8), 7-9 (2) Volatilization Table 7-8, (3-5), 7-9, (1) Fugitive Dust Wind Erosion Table 7-8, (3-6), 7-9, (1) Sec. 7.2.5 Seepage, Table 7-8, (7,8) Table 7-9, (2) Pumpage OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-24

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
TRENCHES A, B, AND C (IHSS 166.1 - 166.3)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-7, (1-6)	Fugitive Dust Wind Erosion Section 7.2.5 Air Sampling Table 7-7, (4)	Air Section 7.2.5 Surface Water Table 7-7, (4) Table 7-3, (11)	Settled Dust on Plants – Phase II Settled Dust on Soil Section 7.2.5 Table 7-7, (4) Table 7-3, (11) Settled Dust on Water Table 7-3, (11) Biotic Uptake Section 9
Contaminated Soil Table 7-7, (4)	Surface Runoff Table 7-7, (4) Table 7-3, (11) Volatilization Table 7-7, (4) Infiltration Percolation Table 7-7, (4-6) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-7, (5,6) Biota Section 9	Deposition Table 7-7, (4) Table 7-3, (11) Irrigation OU 3 Work Plan Infiltration Table 7-7, (4-6) Volatilization Table 7-7, (4); 7-3, (11) Fugitive Dust Wind Erosion Table 7-7, (4); 7-3, (11) Seepage Table 7-7, (4-6) Pumpage Table 7-7, (5,6); OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-25

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
SLUDGE DISPERSAL AREA (IHSS 141)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Contaminated Soil Table 7-1, (2)	Surface Runoff Table 7-1, (2) Table 7-3, (1,2) Volatilization Table 7-1, (2) Infiltration Percolation Table 7-1, (3,4) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-1, (3,4) Biota Section 9	Deposition Table 7-1, (2) Table 7-3, (1,2) Irrigation OU 3 Work Plan Infiltration Table 7-1, (3,4) Volatilization Table 7-1, (2), 7-3, (1,2) Fugitive Dust Wind Erosion Table 7-1, (2), 7-3, (1,2) Sec. 7.2.5 Seepage, Table 7-2, Table 7-1, (3,4) Pumpage OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-26

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS:
TRIANGLE AREA (IHSS 165)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Contaminated Soil Table 7-6, (3-7)	Surface Runoff Table 7-6, (4,8) Table 7-3, (11) Volatilization Table 7-6, (4) Infiltration Percolation Table 7-6, (7,9,10) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-6, (9,10) Biota Section 9	Deposition Table 7-6, (4) Table 7-3, (11) Irrigation OU 3 Work Plan Infiltration Table 7-6, (7,9,10) Volatilization Table 7-6, (4), 7-3, (11) Fugitive Dust Wind Erosion Table 7-6, (4), 7-3, (11) Sec. 7.2.5 Seepage, Table 7-6, (7,9,10) Pumpage OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-27

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS: OLD OUTFALL (IHSS 143)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-4, (1-5)	Fugitive Dust Wind Erosion Section 7.2.5 Air Sampling Table 7-4, (2,4)	Air Section 7.2.5 Surface Water Table 7-4, (1) Table 7-3, (7)	Settled Dust on Plants – Phase II Settled Dust on Soil Section 7.2.5 Table 7-4, (2,4) Table 7-3, (7) Settled Dust on Water Table 7-4, (2,4) Table 7-3, (7) Biotic Uptake Section 9
Contaminated Soil Table 7-4, (1-4)	Surface Runoff Table 7-4, (2,4) Table 7-3, (7) Volatilization Table 7-4, (2,4) Infiltration Percolation Table 7-4, (3-5) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-4, (5) Biota Section 9	Deposition Table 7-4, (2) Table 7-3, (7) Irrigation OU 3 Work Plan Infiltration Table 7-4, (3-5) Volatilization Table 7-4, (2,4), 7-3, (7) Fugitive Dust Wind Erosion Table 7-4, (2-4), 7-3, (7) Sec. 7.2.5 Seepage, Table 7-4, (3-5) Pumpage OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

TABLE 2-28

OU 6 PHASE I SITE CHARACTERIZATION OF EXPOSURE PATHWAYS: SOIL DUMP AREA (IHSS 156.2)

Contaminant Source	Primary Release Mechanism	Transport Media	Secondary Release Mechanism
Buried Waste Table 7-5, (1-6)	Fugitive Dust Wind Erosion Section 7.2.5 Air Sampling Table 7-5, (3)	Air Section 7.2.5 Surface Water Table 7-5, (3) Table 7-3, (1,2)	Settled Dust on Plants – Phase II Settled Dust on Soil Section 7.2.5 Table 7-5, (3) Table 7-3, (1,2) Settled Dust on Water Table 7-5, (3) Table 7-3, (1,2) Biotic Uptake Section 9
Contaminated Surface Soil Table 7-5, (1-4)	Surface Runoff Table 7-5, (3) Table 7-4, (1,2) Volatilization Table 7-5, (3) Infiltration Percolation Table 7-5, (4-6) Biotic Uptake Section 9 Tracking Section 9	Groundwater Table 7-5, (5,6) Biota Section 9	Deposition Table 7-5, (3) Table 7-3, (1,2) Irrigation OU 3 Work Plan Infiltration Table 7-5, (4-6) Volatilization Table 7-5, (3), 7-3, (1,2) Fugitive Dust Wind Erosion Table 7-5, (3), 7-3, (1,2) Sec. 7.2.5 Seepage, Table 7-2, Table 7-5, (4-6) Pumpage OU 3 Work Plan Biotic Uptake Section 9 Biodegradation-Phase II

7.1 BACKGROUND AND SAMPLING RATIONALE

7.1.1 Background

The objectives of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) are:

- To characterize the physical and hydrogeologic setting of the Individual Hazardous Substance Sites (IHSSs)
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified in Section 4.0. The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will address the data needs and data quality objectives. The FSP developed in this section is based on the requirements of the IAG Statement of Work for Operable Unit 6 (OU6), and the data needs developed in Section 4.0. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to the feasibility studies.

Generally, only limited information is available concerning the IHSSs in OU6 since there have been few previous investigations. Available information includes aerial photographs, site histories, and some analytical data for samples collected near the IHSSs. Little or no information exists specific to the physical characteristics of the sites, except for some of the A- and B-series ponds, or the nature and extent of the contamination, if present.

One of the objectives of the RFI/RI is to assess the presence or absence of contamination in the groundwater, surface water, and soils at the sites. A staged approach as outlined in the IAG will be used in Phase I to achieve this objective. This approach requires an iterative process involving continuing reassessment of the site condition as the data are obtained. Based on this process, the subsequent field sampling program may be modified to collect more representative data for each IHSS. This FSP describes this staged process.

Based on the previous investigations and historical data presented in Section 2.0 of this report, the primary potential contaminants of concern are radioactive materials. Insufficient data exists to confirm or deny the presence of metals or organic compounds in IHSSs within OU6.

7.1.2 Sampling Rationale

As discussed above, a staged approach will be used for the sampling program. There are a total of four stages which may be completed at any site.

- Stage 1 consists of a review of existing data, including aerial photographs and site records. Data from ongoing or other operable unit investigations that have become available since preparation of this Phase I work plan will also be compiled and evaluated. These data will be validated as appropriate for incorporation into the OU6 site characterization. This review of existing information has already been partially performed during preparation of this Phase I work plan.

- Stage 2 involves screening activities, including radiation surveys, a soil gas survey in the Triangle Area, and an electromagnetic geophysical survey at the Trenches. The radiation and soil gas surveys are designed to provide Phase I screening-level data concerning the presence or absence of contaminants at these sites. The geophysical survey will provide data on the depth and lateral extent of the Trenches.

- Stage 3 consists of Phase I sampling activities for soil, sediment and surface water. Soil borings will be completed at some IHSSs to collect samples at depth and to characterize the IHSS. Some of the sampling locations may be selected to investigate anomalies identified in the Stage 2 soil gas and radiation surveys. This stage will provide confirmation of the Phase I screening data as well as aid in Phase I geologic and hydrogeologic characterization of the sites.

- Stage 4 is monitoring well installation and sampling, which will follow the Stage 3 characterization and sampling. Groundwater monitoring wells will be installed to characterize the hydrogeologic setting of each site and to monitor alluvial groundwater conditions within or downgradient of several sites. These wells will be sampled after completion and development, and the results will be included in the Phase I RFI/RI Report.

7.1.3 Modifications to the IAG Plan

Several sampling and analytical activities described in the IAG have been modified in this FSP. These modifications, listed below, have been made so that each IHSS can be better evaluated during the Phase I investigation. Modifications to the Phase I sampling program are presented first followed by the modification to the Phase I analytical program.

Phase I Sampling Program Modifications

1) Both the Triangle Area (IHSS 165) and the Old Outfall (IHSS 143) appear to have been modified since waste disposal activities ceased at these locations. Fill has been added (origin of the fill unknown) and buildings have been constructed on the Old Outfall after waste disposal activities were discontinued. As much as 8 to 10 feet of fill may exist over the original surface. In addition, about 6 inches of surface fill has also been placed over parts of the Triangle Area. The Field Sampling Plan has been modified so that the surface soil sampling specified in the IAG can be taken from the original surfaces of these units. This will entail using borings to drill down to the original land surface so that samples can be collected at and below this surface. Composite samples of the fill will also be collected to determine if any contamination is present. The modifications to this sampling program are described in subsections 7.2.3 and 7.2.5.

2) Two-foot composite samples will not be used for volatile organics analysis at the Triangle Area (IHSS 165) or Trenches (IHSS 166). Instead, discrete samples will be collected at two-foot increments for analysis. Composite samples are not appropriate for analysis of volatile organic compounds, since a significant portion of the volatiles present in a sample can be volatilized during compositing of a sample.

3) The soil gas survey at the Triangle Area (IHSS 165) will be conducted on a 100-foot offset grid instead of the 50-foot grid specified in the IAG. If areas of anomalous radiation readings are detected, the size of the grid will be reduced in that area to locate the organics source.

4) One of the wells proposed in the Triangle Area (IHSS 165) within the PSZ will be drilled 20 feet into bedrock. If a sandstone zone is encountered, an additional well will be screened in the first sandstone zone in the bedrock. If there is not a sandstone zone in the boring, only one well will be completed in the saturated alluvium at that location. The purpose of the bedrock well is to confirm bedrock geology in this area and identify contamination, if present.

5) One well will be installed to monitor the saturated alluvium downgradient (east-southeast) of IHSS 166.2 (Trench B). It is suspected, based on the local topography, that Trench B may be near a groundwater drainage divide. Groundwater flow to the north from the trenches is monitored by several wells while no monitoring wells exist to the east. The purpose of this additional well will be to provide data on possible groundwater contamination adjacent to this trench and in the eastward flow direction. An additional alluvial well will be installed downgradient and immediately to the north of the eastern Trench C.

6) Five sediment samples are to be collected in each A-series and B-series pond as proposed in the IAG. However, three of the five locations have been changed so that more representative samples of the pond sediment can be obtained. The five locations proposed in this Phase I FSP are:

- In the deepest portion of the pond,
- In the pond, five feet from the inlet, and
- At three randomly selected locations within the pond.

The samples to be collected at the three random locations are the locations which have been changed from those specified in the IAG. These random samples will provide pond sediment data that can be statistically averaged, while the sediment samples collected from the deepest part of the ponds are likely to provide worst case concentrations. These average and worst case concentrations can then be used to better characterize the extent and nature of any contamination in the ponds and provide more useful data for the Phase I baseline risk assessment. The three original sampling locations specified in the IAG would provide non-random data that cannot be used in statistical analyses.

7) Surface and subsurface samples will be collected in the North, Pond and South Area Spray Fields (IHSSs 167.1, 167.2 and 167.3) on 100-foot grids. Since homogeneous liquids were sprayed across the spray fields, the 100-foot grid should adequately characterize the nature and extent of contamination, if present. In addition, one sediment samples will be collected in the drainage immediately east of the North Spray Field as part of the site-wide surface water and sediment sampling program and a second sample will be collected immediately downgradient and north of the South Spray Field so as to characterize potential downstream contamination from these units.

8) Surface and subsurface soil samples will be collected on a 200-foot grid from the East Area Spray Field (IHSS 216.1). The purpose of these additional samples is to evaluate the presence or absence of contamination in that area. The rationale for this sampling is that if contamination is not found, then this IHSS may be removed from further phases of the RFI/RI process.

9) IHSS 156.2, the Soil Dump Area, has been moved from Operable Unit No. 14 into OU6. The field sampling plan for this unit will consist of a germanium surface radiation survey over the entire site instead of the proposed FIDLER survey specified in the IAG as the germanium survey should be a superior radiation detection technique. Surface and subsurface samples will be taken on a 150-foot grid across this IHSS instead of the 50-foot grid around the perimeter as proposed in the IAG. The rationale for this is that it is better to sample the waste pile present within this IHSS than the perimeter of the unit. This sampling along with the surface germanium radiation survey should more adequately characterize the nature and extent of contamination, if present in this area. In addition, one alluvial well will be located in the western part of the unit and one will be drilled 20 feet into bedrock within this IHSS and will be completed as a bedrock well if a sandstone zone is encountered.

10) Sediment samples will be collected from the drainages in OU6 to characterize areas where existing data is currently lacking. Proposed sediment samples have been located along each stream segment of North and South Walnut creeks where additional characterization is needed. Based on a review of the data collected at the 17 existing locations along the OU6 drainages, there exists a significant amount of information about the sediments in many parts of OU6 (see Section 2.0). Subsequently, the sampling locations specified in the IAG have been reduced where site-wide data already exist with proposed sampling locations placed in areas that need further characterization. Based on this approach, the following sediment sample locations have been identified for OU6: (1) three additional samples have been added to South Walnut Creek to augment the five existing stations and 25 pond sediment samples that are collected in this area; (2) three sediment stations have been added to North Walnut Creek to supplement the six existing and 20 pond sediment locations; (3) two sediment locations have been added to Walnut Creek downgradient of the junction of North and South Walnut Creek to supplement the one existing and five pond sediment samples that are collected in this area; (4) two locations have been added to the unnamed tributaries north of North Walnut Creek just downstream of IHSSs 167.1 and 167.2 to supplement the existing three sediment samples along this drainage; and (5) two dry surface sediment samples will be collected at the inlet to each of the A- and B-series detention ponds (18 total) to address the risk from direct dermal contact, and wind eroded injestion and dermal contact. These proposed sampling locations in combination with the 17 existing sediment stations in this area and the 68 sediment samples to be collected from the detention ponds should be sufficient to characterize the drainages in OU6. In addition to the above, two more sediment locations have been located south of the Triangle Area and one north of the Triangle Area to determine if the drainage from this IHSS has affected the area downslope of this unit.

11) Five bedrock wells will be installed in the vicinity of North Walnut Creek during the OU6 investigation. The purpose of these wells is to characterize the bedrock in the vicinity of the A-series ponds.

Analytical Program Modifications

1) Soil samples from the preexisting surface (below the fill) of the Triangle Area (IHSS 165) will be analyzed for metals as well as for radioactive elements. This should provide more specific data on the potential for metals contamination at this site. Metal analyses have been added to this site because the wastes that were placed in this area may have contained metals, and for consistency, since the groundwater monitoring program calls for analysis of metals in wells near this IHSS.

2) A gamma radiation scan will be conducted by EG&G or its contractor on each of the sediment samples collected from the location at the deepest portion of the A- and B-series ponds. Sediment samples at these locations will be collected from the sediment core at five-centimeter intervals. The rationale behind this analysis is to evaluate whether contamination may exist in thinly stratified layers and to provide additional data to characterize pond sediment.

3) The IAG specifies that water and sediment samples be analyzed for soluble and insoluble radionuclides and metals. For the purposes of this Phase I investigation, each of the water samples will be filtered, with both the filtered and unfiltered aliquots analyzed for the specified metals and radionuclides. The filtered samples will provide data on the dissolved constituents and the unfiltered samples will provide data on the total constituent concentrations. Also, water samples (both filtered and unfiltered) and sediments will be analyzed for both plutonium isotopes (239/240). This is consistent with the existing Rocky Flats analytical methods.

4) Several analyses have been added to the Phase I analytical program to assess chemicals of interest in the Environmental Evaluation. Groundwater from wells at the Triangle Area (IHSS 165), Trenches A, B and C (IHSS 166), the North and South Area Spray Fields (IHSSs 167.1 and 167.3) and all the sediment samples collected in Walnut Creek (excluding the pond samples) will be analyzed for TCL pesticides/PCBs. For the pond sediment samples, the sample from the deepest part of the pond and from the inlet area will be analyzed for TCL pesticides/PCBs. All surface (0-2 inches) soil samples taken in OU6 and sediment samples collected in Walnut Creek and the Ponds will be analyzed for total organic carbon (TOC).

7.2 INVESTIGATION PROGRAM

This section describes the Phase I investigation program for the IHSSs within OU6. For each IHSS, the tasks listed are generally divided into office activities prior to field sampling (Stage 1), field screening activities prior to sampling (Stage 2), field sampling activities (Stage 3), and groundwater monitoring well installation and sampling (Stage 4). As part of the field sampling program, data from the site-wide monitoring program and investigations at other OUs will be used as appropriate to add to, or substitute for, the data collected during the Phase I investigation. The sites in OU6 are IHSS 141 - Sludge Dispersal Area, IHSS 142.1-9, 12 - A and B Series Detention Ponds, IHSS 143 - Old Outfall, IHSS 156.2 -Soil Dump Area, IHSS 165 -Triangle Area, IHSS 166 - Trenches A, B and C, IHSS 167 - North, Pond, and South Area Spray Fields, and IHSS 216.1 - East Spray Fields - North Area. For reference, the Phase I investigation programs for each IHSS are summarized below. A number of standard operating procedures (SOPs) will be used during the investigation. The SOPs are cited in this section and discussed further in Section 11.0 of this Phase I work plan.

7.2.1 IHSS 141 - Sludge Dispersal Area

Stage 1 - Review of Existing Data and Radiation Survey

After review of existing data, a radiation survey will be performed over the areas affected by IHSS 141 (see Table 7-1). The radiation readings will be taken on a 25 ft. grid according to the procedure described in SOP FO.16 (Field Radiological Measurements) (Figure 7-1). If areas of anomalous radiation readings are detected, the size of the grid will be reduced in that area to locate the radiation source. The results will be plotted and contoured on a map. The Phase I survey will be conducted using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake-type detector.

Stage 2 - Surface Soil Sampling

Surface soil samples will be collected to a depth of 2 in. on a 25 ft. grid over IHSS 141 (Figure 7-1) according to the procedures in GT.8, Surface Soil Sampling. Surface soil samples will also be collected from areas of anomalous radiation readings located during the radiation survey. Grid points located in paved areas (road) or under buildings within this IHSS will not be collected. A discussion of the analytical program for these samples is contained in subsection 7.3.

Stage 3 - Monitoring Well

One alluvial monitoring well will be installed downgradient of IHSS 141 (a preliminary location is shown on Figure 7-1). The location of the well will be selected after completion of the Stage 2 activities and after a review of the geologic conditions at the site. The proposed well location will be submitted to EPA and CDH for review and approval prior to its installation. This well will be screened to monitor the saturated alluvium. If a water bearing sandstone unit is found to be the first bedrock unit underlying the alluvium, an additional well will be completed in the sandstone unit at that location. The well(s) will be drilled according to SOP GT.2, installed according to SOP GT.6 and developed according to SOP GW.2. Following development, the well(s) will be sampled according to SOPs GW.5 and GW.6. The Phase I analytical program for samples collected from these

TABLE 7-1

PHASE I INVESTIGATION
IHSS 141 - SLUDGE DISPERSAL AREA

Activity	Purpose	Location	Number of Samples or Locations
Radiation survey	Locate areas of anomalous radiation readings	Entire site - 25 ft grid	NA
Surface soil sampling	Characterize surface contamination and areas of anomalous radiation readings	Entire site - 25 ft grid and areas of anomalous radiation readings except under buildings and roads	60
Install alluvial well	Monitor alluvial groundwater downgradient of the unit	See Figure 7-1	1
Install weathered bedrock sandstone well	Monitor bedrock groundwater downgradient of the unit in weathered sandstone, if it exists at the bedrock contact	Well pair with alluvial well, see Figure 7-1	possible 1

NA - Not Applicable

wells are contained in Section 7.3. The results of the first round of sampling will be reported in the Phase I Report. The well(s) will be sampled and quarterly basis for a minimum of one year.

7.2.2 IHSS 142.1-9, 12 - A and B Series Detention Ponds

Stage 1 - Review Existing Data

Surface water and sediment samples are currently being collected at locations in the Walnut Creek drainage as part of ongoing monitoring activities at the Rocky Flats Plant. The sampling locations, methodology, analytical parameters, and results from this monitoring will be reviewed prior to Phase I activities to assess potential overlap between programs. Data collected during these ongoing monitoring activities may satisfy the requirements of this OU6 program and will be utilized, if appropriate (Table 7-2). Also, as specified in the IAG, the 1986 Rockwell International report entitled "Trends in the Rocky Flats Surface Water Monitoring" (U.S. DOE 1986a) and other data pertaining to these ponds will be submitted to the EPA and CDH.

Stage 2 - Surface Water and Sediment Samples

Five surface water samples will be collected from each of the four A-Series Detention Ponds and the five B-Series Detention Ponds and IHSS 142.12. At least one of the five water samples from each pond will be taken from the deepest part of the pond. As specified in the IAG, stratification of the water column at this location will be identified through temperature and/or dissolved oxygen measurements taken according to SOP SW.8. If stratification of the pond is identified, grab water samples will be taken from each vertically stratified zone. The second water sample from each pond will be collected from within 5 feet of the inlet of the pond. The third water sample from each pond will be taken within 5 feet of the pond spillway. The other two sampling locations will be randomly selected based on the size of the pond at the time of sampling. The surface water sample collected at each location will consist of a composite sample from the entire vertical water column, except for the grab samples at the deepest sampling location (described above). Samples will be collected according to SOPs SW.1, SW.2, and SW.8 as they apply to pond water sampling.

Five sediment samples will be collected from each of four A-Series Detention Ponds; the five B-Series Detention Ponds and IHSS 142.12 (Figures 7-2 and 7-3). One of the five sediment samples will be collected from within 5 feet of the pond inlet. The second sediment sample will be taken from the deepest parts of each pond. The other three samples will be taken at random locations within the area of the pond as it exists at the time of sampling. All sediment samples will represent the entire vertical column of sediment present at each location. If sediment depth is greater than 2 feet, 2-foot composite samples will be collected to represent the entire vertical column of sediment present at each location. Surface sediment samples will be collected to a depth of two inches. Sediment samples will be geologically logged according to SOP GT.1.

TABLE 7-2

PHASE I INVESTIGATION
IHSS 142.1-9 and 142.12 - A and B SERIES PONDS

Activity	Purpose	Location	Number of Samples or Locations
Collect surface water samples	Characterize surface water contamination	5 locations in each pond and from each vertically stratified zone at the deepest point in the pond	72
Collect sediment samples in ponds	Characterize sediments in ponds and contamination	5 locations in each pond. Samples will also be taken from each 5 centimeter interval of sediment from the deepest part of each pond.	50
Collect sediment samples in other locations on Walnut Creek	Characterize Walnut Creek sediments and contamination	See Figure 7-4 and text.	13
Collect dry surface sediment samples	Determine risk from dust dermal contact, and wind eroded ingestion and dermal contact.	2 locations at inlet to each of the A and B series ponds. Two-inch depth.	18
Install weathered bedrock sandstone wells	Monitor bedrock groundwater downgradient of Ponds A-4 and B-5 in weathered sandstone if it exists at the bedrock contact.	Well pair with alluvial wells, see Figures 7-2 and 7-3.	possibly 2
Install alluvial wells	Monitor alluvial groundwater downgradient of the Ponds A-4 and B-5	Below ponds A-4 and B-5 dams (2 each)	4
Install unweathered bedrock sandstone wells	Further characterize the bedrock of North Walnut Creek and determine if the Arapahoe No. 4 sand is present in the area.	See Figure 7-4.	5

In addition to the above samples, grab sediment samples will be collected from discrete vertical intervals in the sediment core taken from the deepest part of the pond. These sediment samples will consist of composite samples collected at 5-centimeter intervals in this core. Each of these samples will be analyzed by a gamma radiation scan.

In addition, two dry surface sediment samples will be collected at the inlet to each of the A- and B-Series Detention Ponds. These samples will be collected to a depth of two inches. This data will address the risk from direct dermal contact and wind eroded ingestion and dermal contact (not presented in Figure 7-3).

Sediment samples will also be collected along Walnut Creek from adjacent to Parking Area No. 71 to Indiana Street (Figure 7-4). There already exist data on the sediments in the OU6 area (see Section 2.0). These existing data were used to focus the Phase I sediment data collection effort in areas where there are data gaps. In addition, the sediment samples that are collected from the individual detention ponds should also provide a significant amount of information on the sediments in this area. This pond sediment data is considered particularly important for characterizing the contamination present in this drainage because the contaminants should be preferentially present in the finer-grained sediments that exist in these ponds.

Based on the existing sediment sampling locations within the detention ponds and near the IHSSs along this drainage, the Phase I sediment sampling locations for this work plan were selected (Figure 7-4). Table 7-3 contains the Phase I sediment sampling program (both existing and proposed) which has been developed for OU6. Generally, additional sampling locations have been placed downstream of each IHSS and along each stream segment where existing data is lacking to characterize this drainage. This proposed sampling program along with the existing site-wide sediment program should be able to adequately characterize the drainages within OU6 and to determine if there has been any impact from the individual IHSSs located along it. If contaminants are detected, additional sediment samples will be collected as needed to characterize these areas.

In addition to the above sediment samples, two samples will be collected south of the triangle area to determine if this area has been affected by runoff from this IHSS (Figure 7-4). One of these locations along the south boundary of this IHSS will sample the sediment at the upstream end of a culvert that runs underneath the PSZ. The second sediment location, southwest of the Triangle Area, will be used to characterize the sediment that are present in this area.

These stream sediment samples will be collected within the stream at points that are conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than two feet, then two-foot composite samples will be collected to represent the entire vertical column of sediment present at each

TABLE 7-3

PROPOSED SEDIMENT SAMPLING PROGRAM

Stream Segment of Location	Proposed Locations	Existing Locations	IHSSs Upslope of Segment	Length of Stream Segment
South Walnut Creek				
Upstream of IHSS 141	3	SED-11	IHSS 165	600 ft.
Between IHSS 141 and Pond B-1	None	SED-12	IHSS 141	400 ft.
Between Ponds B-1 and B-4	20*	None	IHSSs 216.1, 156.2, 142.5, 142.6, 142.7, and 142.8	1,000 ft.
Between Ponds B-4 and B-5	1	SED-32	IHSS 216.1	900 ft.
Between Pond B-5 and junction with North Walnut Creek	1	SED-13 SED-33	None	1,650 ft.
North Walnut Creek				
Between SED 118 and Pond A-1	2	SED-118 SED-9	IHSSs 113, 166.2, 166.3, and 165	3,000 ft.
Between IHSS 165 and Pond A-1	1	SW-91	IHSS 165	1,000 ft.
Between Ponds A-1 and A-3	15*	None	IHSSs 156.2, 216.1, 142.1, 142.2, and 142.3	2,400 ft.
Between Ponds A-3 and A-4	6*	None	None	1,400 ft.
Between Pond A-4 and junction with South Walnut Creek	1	SED-8	None	600 ft.
Walnut Creek between junction of North and South Walnut Creek and Indiana	2	SED-3	IHSS 142.12	360 ft.

TABLE 7-3
(Concluded)

Stream Segment of Location	Proposed Locations	Existing Locations	IHSSs Upslope of Segment	Length of Stream Segment
Downgradient of IHSS 167.1 on unnamed tributary	1	None	167.1	900 ft.
Downgradient of IHSS 167.3 on unnamed tributary	1	SED-6	167.3	900 ft.

* Pond sediment sampling locations – five samples per pond (not shown on Figure 7-4).

location. All sediment samples listed above will be collected according to SOP SW.1, SW.2, SW.3, SW.6 and the SOP Addendum (SOPA) to SOP SW.6 in Section 11.0 of this document. The chemical analyses that will be performed on these samples are presented in subsection 7.3.

Stage 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of each dam at Pond A-4 and at Pond B-5 for a total of 4 wells (Figure 7-2 and Figure 7-3). The wells will be constructed within the original stream channel according to SOP GT.6 and will monitor the saturated alluvium. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium, an additional well will be completed in the sandstone unit at that location. Following development of the wells according to SOP GW.2, the wells will be sampled according to SOPs GW.5 and GW.6. Results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for a minimum of one year. The analytical program for samples from these wells is discussed in subsection 7.3.

In addition, five bedrock monitoring wells will be installed in the North Walnut Creek area to further characterize the bedrock and to determine if the Arapahoe No. 4 sand is present in this area. These bedrock wells will be cored only in the interval in which they will be completed. The five wells will be installed in the approximate locations shown on Figure 7-4 to depths ranging from 80 to 120 feet. Drilling fluids and cuttings from these wells will be handled according to SOP FO.8 and the wells will be completed in accordance with SOP GT.6. Following development of the wells (SOP GW.2), the wells will be sampled on a quarterly basis for a minimum of one year. The analytical program for samples from these wells is discussed in subsection 7.3.

7.2.3 IHSS 143 - Old Outfall

Stage 1 - Review existing data and Radiation Survey

After review of existing data, a radiation survey will be performed over the area affected by IHSS 143 according to SOP FO.16. The radiation readings will be taken on a 10-foot grid (Table 7-4). If areas of anomalous radiation readings are detected, the size of the grid will be reduced in that area to pinpoint the radiation source. The results will be plotted and contoured on a map. The survey will be conducted using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake-type detector.

Stage 2 - Surface and Subsurface Soil Sampling

TABLE 7-4

PHASE I INVESTIGATION
IHSS 143 - OLD OUTFALL AREA

Activity	Purpose	Location	Number of Samples or Locations
Radiation survey	Locate areas of anomalous radiation readings	Entire site - 10 ft grid	NA
Surface soil sampling	Characterize surface soil chemistry and areas of anomalous radiation readings as determined by radiation survey	Randomly selected locations from borehole locations and areas of anomalous radiation readings	4+
Subsurface soil sampling	Characterize top two feet of pre-fill surface and areas of anomalous radiation readings	Sampling will extend to 2 feet below the original pre-fill surface (Figure 7-5)	11
Fill sampling	Determine if contamination is present in fill	Composite sample of fill from every fourth soil boring	3
Install alluvial well	Monitor alluvial groundwater downgradient of old outfall area screening	Downgradient of unit in northern part of IHSS near stream outlet	1

NA - Not Applicable

In order to obtain confirmatory surface soil characterization data, four randomly selected surface samples from the soil boring grid will be collected to a depth of 2 inches below the existing ground surface, according to SOP GT.8.

In addition, surface soil samples will be collected at the central location of all areas identified by the radiation survey as having above-background radiation levels. These samples will be collected according to SOP GT.8.

The Old Outfall is an area where fill has been placed since waste discharge activities ceased at this site. Fill thicknesses may vary from 0 to 10 feet. Since the area of interest is the pre-fill ground surface, it will be necessary to drill through the fill to collect samples from the original ground surface. Soil borings in IHSS 143 will be drilled on a 20-foot grid, except under buildings, to a depth of 2 feet below the original pre-fill surface (see Figure 7-5). One sample will be collected from the top of the prefill surface to 2 inches below the prefill surface (discussed previously). The second sample will be collected from 2 inches to 24 inches below the prefill surface. Composite samples will be collected from the entire vertical section of the fill section in every fourth boring. The borings will be drilled according to SOP GT.2. In addition to the above borings, one boring will be drilled just east of the east culvert and sampled similar to the above borings (see Figure 7-5).

Stage 3 - Monitoring Well

One alluvial groundwater well will be installed downgradient of the Old Outfall Area (not shown on Figure 7-5). The well will be located within the PSZ unless cultural features prevent drilling. In that case, an alternative location will be selected downgradient of the IHSS and outside the PSZ. The well be drilled according to SOP GT.2, installed according to SOP GT.6, and developed and tested according to SOP GW.2. Following development, the well will be sampled according to SOPs GW.5 and GW.6. The proposed analytical program for samples from these wells is contained in subsection 7.3. The results of sampling will be reported in the Phase I RI Report. This well will be sampled on a quarterly basis for a minimum of one year.

7.2.4 IHSS 156.2 - Soil Dump Area

Stage 1 - Review Aerial Photographs

Aerial photographs will be evaluated to identify the extent of the Soil Dump Area (Table 7-5).

Stage 2 - Radiation Survey

A ground-based radiation survey employing a high-purity germanium gamma-ray sensor will be performed over the Soil Dump Area. The area to be surveyed for IHSS 156.2 is outlined by the boundary for this IHSS

TABLE 7-5

PHASE I INVESTIGATION
IHSS 156.2 - SOIL DUMP AREA

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs and radiation surveys	Identify extent	Entire site	NA
Radiation Survey	Locate areas of anomalous radiation readings	Entire site	NA
Surface soil samples	Characterize surface materials and contamination and areas of anomalous radiation readings	Entire site - 150-ft grid	14
Soil borings	Characterize subsurface conditions and materials	Entire site - 150-ft grid. Borings will be drilled 3 ft into the undisturbed soils beneath the soil piles	14
Install alluvial wells	Monitor alluvial groundwater within unit	In western part of unit	1
Install bedrock well	Monitor groundwater in bedrock sand zone, if encountered and characterize the hydraulic properties of the sandstone.	In western part of unit	possibly 1

NA - Not Applicable

(Figure 7-1). The germanium sensors employed for this survey will be spaced such that there is overlapping coverage between stations, so that essentially 100% coverage can be obtained. The gamma-emitting radionuclides that are detected will be analyzed to identify the isotopes that may be present. Prior to implementation, an SOP will be developed for performing this survey. If areas of anomalous radiation readings are detected, they will be surveyed sufficiently to define their lateral extent. The results will be plotted and contoured on a map and will also be presented in tabular form.

Stage 3 - Surface Sediment Samples, Surface Soil Samples and Soil Borings

Surface soil samples will be collected to a depth of 2 inches on a 150-foot grid over the Soil Dump Area (Figure 7-1). Surface soil samples will be collected according to SOP GT.8. Soil borings will be drilled 3-feet into the undisturbed soil beneath the soil piles on the same 150-foot grid according to SOP GT.2. Samples will be taken continuously in these boring and will be composited from each 6-foot interval in the fill material. Where the material is less than 6-feet, the entire interval will be composited. A 3-foot composite will be taken of the underlying prefill soil surface. These samples will samples will be analyzed for radioactive elements and TAL metals (see subsection 7.3).

During sampling a soil classification survey will be completed in the Soil Dump Area for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 foot depth for grain size analysis.

Stage 4 - Monitoring Well

One alluvial monitoring wells will be installed in this IHSS to monitor groundwater underlying the Soil Dump Area. The well will be located in the western part of the unit (Figure 7-1). This location was selected because the most potentially contaminated soil was placed near the prefill surface in the western half of the IHSS. Also, the fill is thickest to the west (approximately 20 feet) and tapers to zero feet to the east. A boring will be drilled 20 feet into bedrock. It is possible due to the limited saturated thickness of the alluvium that there may be locations where there is no water or times of the year when the saturated thickness is zero. If this is the case, it may be necessary to relocate the well or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water.

If a sandstone is present, then an additional well will be completed to monitor the sandstone layer. The purpose of this well is to confirm bedrock geology and to characterize the presence of contamination in this area, if present. The well(s) will be drilled according to SOP GT.2, installed according to SOP GT.6, and developed and tested according to SOP GW.2. During slug testing of the bedrock well, Special attention will be directed towards characterizing this stratigraphic sandstone lenses in the bedrock, if present by performing a slug test. Following development, the well will be sampled according to SOPs GW.5 and GW.6. The proposed analytical program for samples from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. This well will be sampled on a quarterly basis for a minimum of one year.

7.2.5 IHSS 165 - Triangle Area

Stage 1 - Review Aerial Photographs

Aerial photographs from 1953, 1964, 1969 and 1971 will be re-evaluated to identify the extent of the disposal area (Table 7-6). The aerial photographs suggest that the site extends farther to the north, east and west than is presently mapped. Additional studies conducted on or near the Triangle Area after preparation of this work plan will also be evaluated. These include investigations currently planned for Operable Unit 2 and the investigation planned for IHSS 176 (S & W Contractor Storage Yard), which partially overlaps this area. Also during Stage 1 any reports or documents concerning the radiometric surveys conducted from 1975 to 1983 and any cleanup activities at this site will be submitted to the EPA and CDH.

Stage 2 - Radiation and Soil Gas Surveys

A radiation survey will be performed over the Triangle Area on a 25-foot grid, excluding the PSZ fence area, (Figure 7-1) according to the procedures specified in SOP FO.16. If areas of anomalous radiation readings are detected, the size of the grid will be reduced in that area to locate the radiation source. The results will be plotted on a map and contoured. The survey will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector.

A real-time soil gas survey will be conducted over the Triangle Area, excluding the PSZ fence area (Figure 7-1) to evaluate the presence of volatile organic compounds. Soil gas samples will be taken on a 100-foot offset grid according to the procedures described in SOP GT.9. If organics are detected, the size of the grid will be reduced in that area to locate the organics source. The probe will be driven two to four feet into the soil, below the fill, if possible, to collect the sample. The soil gas samples will be analyzed for carbon tetrachloride, trichloroethene (TCE), dichloromethane, acetone, 2-butanone, tetrachloroethene (PCE), 1,2-dichloroethane (DCA), chloroform and toluene. Analytical peaks of compounds for which the gas chromatograph (GC) is not calibrated will be noted. The soil gas survey will be conducted using a portable GC. The analytical program for this soil gas survey is further discussed in subsection 7.3.2.

TABLE 7-6

PHASE I INVESTIGATON
IHSS 165 - TRIANGLE AREA

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify extent	Entire site	NA
Radiation survey	Locate areas of anomalous radiation readings	Entire site - excluding PSZ fence - 25 ft grid	NA
Soil gas survey	Locate plumes of volatiles	Entire site - excluding PSZ fence - 100 ft grid	56
Surface soil samples	To confirm screening technologies of radiation and soil gas surveys, if there are no detections. Verify presence or non-presence of volatiles identified during soil gas survey and characterize areas of anomalous radiation readings	VOC and areas of anomalous radiation readings	6-15
Soil cores	Verify presence or non-presence of volatiles identified during soil gas survey	Random basis, 1 sample, every 15 soil gas samples, at the depth of the soil gas probe.	4
Soil classification survey	For Environmental Evaluation	Entire site	NA
Soil borings (if plumes are identified)	Transect plumes identified by soil gas or radiation survey, if identified	Three borings transecting three highest soil gas locations. Borings will be drilled 3 ft. into weathered bedrock.	Maximum of 9
Collect sediment sample	Characterize sediments in ditch discharing north to A Series Ponds.	Adjacent to surface water station (SW-91)	1
Install alluvial wells	Monitor alluvial groundwater under the unit	One well east of PSZ and one west of the PSZ fence in north part of unit within PSZ (Figure 7-1)	2
Install bedrock well	Monitor groundwater in bedrock sand zone, if encountered	Well pair with western alluvial well	Possibly 1

NA - Not Applicable

Stage 3 - Surface Soil Samples, Soil Cores, Soil Borings, and Sediment Samples

Six randomly selected surface soil samples will be selected from the soil gas grid to test the screening techniques. In addition, surface soil samples will be collected at the locations of volatile organic or radiation plumes, if detected. The surface soil samples will be taken at the surface of the fill material and at the original ground surface according to the procedures described in SOP GT.8.

Soil cores will be collected on a random basis to confirm the results of the screening surveys. One soil core will be collected for every 15 soil gas samples at the same depth as the soil gas samples.

During sampling, a soil classification survey will be completed at the Triangle Area for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 foot depth for grain size analysis.

If plumes are identified by the soil gas or radiation survey, soil borings will be utilized to transect the plumes. At each plume area one soil boring will be placed at the location of the highest soil gas reading and two borings will be drilled downgradient of that point. Three borings will be placed at up to three areas where plumes have been identified by the soil gas survey at the Triangle Area, resulting in a maximum of 9 borings for this area. The soil borings will be drilled 3 feet into weathered bedrock according to the procedures described in SOP GT.2. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot increment and analyzed for volatile organic compounds as described in subsection 7.3. Samples will be composited from every 6-foot interval and analyzed for semivolatile organic compounds and radionuclides as described in subsection 7.3. Boreholes at six randomly selected locations will be drilled and sampled to confirm the results of the surveys are negative.

One sediment sampling station will be established adjacent to surface water station SW-91 (not shown on Figure 7-4) in the ditch flowing water toward North Walnut Creek. The stream sediments sample will be collected within the streambed to a point that is conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than 2 feet, then 2-foot composite samples will be collected to represent the entire vertical column of sediment present. The sediment sample will be collected according to SOP SW.1, SW.2, SW.6 and SOP Addendum (SOPA) to SOP SW.6. The chemical analyses that will be performed on these samples are presented in subsection 7.3.

Stage 4 - Monitoring Wells

Two monitoring wells will be installed within IHSS 165 to monitor the alluvial groundwater in the Triangle Area. Two locations have been tentatively selected on the north side of the Triangle Area where there are currently no wells present (preliminary locations are shown on Figure 7-1). One of these wells will be located east of the PSZ fence, and the other well will be located within the PSZ. Final locations for the Phase I wells will be selected following a review of the existing well locations at the time of the investigation. It is possible due to the limited saturated thickness of the alluvium that there may be locations where there is no water or times of the year when the saturated thickness is zero. If this is the case, it may be necessary to relocate the wells or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water. The wells will be drilled according to SOP GT.2 and installed according to SOP GT.6. The well west of the PSZ fence will be drilled 20 feet into bedrock. If a sandstone zone is present in this boring, then the an additional well will be completed in the sandstone. If the sand is not present, the well will be completed in the saturated alluvium. The well east of the PSZ fence will be completed in the saturated alluvium. The wells will be developed according to SOP GW.2. Following development, the wells will be sampled according to SOPs GW.5 and GW.6. The proposed analytical program for samples from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. These wells will be sampled on a quarterly basis for a minimum of one year.

7.2.6 IHSS 166 - Trenches A, B, and C

Stage 1 - Review Aerial Photographs

Aerial photographs from 1964 and 1969 will be re-evaluated to identify the extent of the trenches (Table 7-7). The dimensions and locations of the trenches will be measured from the aerial photographs and used for preliminary locations for the geophysical surveys.

Stage 2 - Geophysical Survey

Surface geophysical techniques will be utilized to estimate the location and lateral extent of Trenches A, B, and C. Electromagnetics (EM) methods will be employed. Electrical conductivity variations are expected between the undisturbed soils and rock and those areas disturbed by trenching and sludge deposits. EM methods provide a rapid means of measuring the electrical conductivity of subsurface soil, rock, and groundwater. Analysis of conductivity variations should allow the trenches to be mapped.

The EM method involves induction of electrical current into the earth. A time-varying magnetic field is generated by a transmitter coil inducting a current into the ground. This primary field induces a secondary field that is measured by a receiver coil. Changes in magnitude and phase of the individual currents are converted to voltages and output in ground conductivity values. These values are then analyzed for variations across the site.

TABLE 7-7

PHASE I INVESTIGATION
IHSS 166 - TRENCHES A, B, AND C

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify location and extent of the trenches	Entire site	NA
Geophysical survey	Locate and delineate extent of the trenches	Each trench area	NA
Soil borings	Characterize materials and contamination in trenches and size of trench	Transecting the trenches longitudinally every 25 ft. Borings will be drilled to 5 ft below the bottom of the trench.	26
Soil classification survey	For Environmental Evaluation	Entire site	NA
Install alluvial well	Monitor alluvial groundwater downgradient of Trench B (166.2)	In most eastward boring at IHSS 166.2, immediately east of the trench and downgradient, immediately to the north of the eastern Trench C (Figure 7-6).	possibly 2
Install bedrock wells	Monitor groundwater in bedrock sand zone, if encountered, and if alluvium is dry	Well pair with alluvial well above	possibly 2

NA - Not Applicable

The EM survey will be conducted over the suspected trench locations. Sufficient data will be collected to obtain "background level" conductivities. General EM line locations are shown in Figure 7-6. Approximately 4,500 feet of EM data will be collected utilizing a 10-foot station spacing. This spacing will allow good resolution of trench lateral extent.

A geonics EM-31 ground conductivity meter will be used for the EM data collection. Data will be collected in the horizontal dipole mode, which provides depth penetration to nine feet, and the vertical dipole mode, which provides depth penetration to 18 feet. Given the shallow depth of the Arapahoe/Laramie Formation in this area (8-15 feet), these penetration depths will be sufficient. However, preliminary analysis will allow a determination if increased penetration is required. If so, a geonics EM-34 will also be used allowing penetration depths of 25-30 feet.

After completion of the survey, conductivity values will be plotted and contoured over each grid area. A non-disturbed area and the trench locations will be evaluated in this interpretation. If the EM method is unsuccessful, ground penetrating radar (GPR) will be used to aid trench detection and delineation. GPR is an electromagnetic sounding technique, and operates on the principle that electromagnetic waves emitted from a transmitter antenna are reflected from buried objects and detected at a receiver antenna. Reflections are observed for subsurface materials that have different dielectric conductivities than the host material. Subsurface metal, refuse, or trench edges often possess substantial dielectric conductivity contrasts allowing these subsurface features to be mapped. Under favorable conditions, subsurface features can be detected to 20 or 30 feet.

In practice, the success of a GPR survey is highly site dependent. The depth of GPR penetration is a function of the near-surface soil conductivity. In areas where clay or conductive soil is near the surface, penetration can be reduced to a couple of feet or less. For this reason, a test line will be conducted at each survey site to ensure penetration is sufficient to detect subsurface trenches. The test line will also test various antennas for an optimum choice, as well as determine data recording parameters.

Upon confirmation that the method is producing sufficient penetration, a series of profiles will be conducted at each survey site over suspected trench areas. A Subsurface Interface Radar (SIR)-3 or SIR-8 antenna system will be used to collect the radar data. Profile radar results will be correlated to all other data, both geophysical and geological, to interpret trench locations.

Stage 3 - Soil Borings

As specified in the IAG, soil borings will be drilled on 25-foot centers along the long axis of each of the trenches (Figure 7-6). The borings will be drilled and sampled according to SOP GT.2 and will be terminated

5 feet below the bottom of each trench. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot interval and analyzed for TCL volatiles. Samples will be composited from every 6-foot interval and analyzed for TAL metals, and radioactive elements (see subsection 7.3). Since it is possible that groundwater may be encountered in these borings, the borings should be completed during the period of low water table in the fall to limit the potential of encountering groundwater in the borings.

During sampling a soil classification survey will be completed at the Trenches for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Stage 4 - Monitoring Wells

Monitoring wells will be installed at Trenches B and C only. At Trench A, wells 63-89, 64-89, and 72-87 will monitor any potential releases from this unit. One monitoring well will be installed to monitor the saturated alluvium downgradient of Trench B (Figure 7-6). This well will be installed in the most eastward boring at Trench B, immediately east of the trench. An additional alluvial well will be installed downgradient and immediately to the north of the eastern Trench C (not shown on Figure 7-6). If the alluvium is dry, and the bedrock consists of sandstone, then the wells will be installed in the saturated portion of the sandstone. If a subcropping sandstone is encountered and the alluvium is saturated, a well pair will be installed. If the alluvium is dry and a subcropping sandstone is not encountered, it may be necessary to relocate the wells or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water. These wells will be installed according to the procedures described in SOP GT.6, developed according to SOP GW.2 and sampled according to SOPs GW.5 and GW.6 following development. Results of sampling will be reported in the Phase I RI Report. These wells will be sampled on a quarterly basis for a minimum of one year.

7.2.7 IHSS 167 - North, Pond, and South Area Spray Fields

Stage 1 - Review Aerial Photographs

Aerial photographs from 1988 will be reviewed to evaluate the location and extent of the north, south, and pond area spray fields (Table 7-8). The sampling program proposed in Stage 2 may be modified if the sizes of these IHSSs are modified.

Stage 2 - Surface Soil Samples, Soil Borings, Sediment and Surface Water Sampling

Surface soil samples will be collected to a depth of 2 inches on a 100-foot grid over the areas of the spray fields as estimated from the aerial photo review conducted in Stage 1 (Figure 7-6). Surface soil samples will

TABLE 7-8

PHASE I INVESTIGATION
IHSS 167 - NORTH, POND, AND SOUTH AREA SPRAY FIELDS

Activity	Purpose	Location	Number of Samples or Locations
Review aerial photographs	Identify location and extent of the units	Entire site	NA
Surface soil sampling	Characterize surface contamination	Entire site - 100 ft grid	57
Soil borings	Characterize subsurface conditions and contamination to 4 ft.	Entire site - 100 ft grid	57
Soil classification survey	For Environmental Evaluation	Entire site	NA
Collect sediment samples	Characterize sediments and contamination downstream of the unit	Within the drainage downstream of the ~~unit~~	2
Collect surface water samples	Characterize surface downgstream of IHSSs 167 and 167.3	On unnamed tributary downgradient of the North and South Area Spray Fields (Figure 7-6).	2
Install alluvial wells	Monitor alluvial ground water downgradient of the spray fields	Within the drainages downgradient of units 167.1 and 167.3	2
Install bedrock well	Monitor groundwater in weathered bedrock sand zone, if encountered.	Well pairs with alluvial wells above	possible 2

NA - Not Applicable

be collected according to SOP GT.8. Soil borings will be drilled to a depth of 4 feet on the same 100-foot grid according to SOP GT.2. Samples will be taken continuously and will be composited from each 2-foot interval. The analytical program for these samples is described in subsection 7.3.

During sampling a soil classification survey will be completed at the Spray Fields for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.
Two stream sediment samples will be collected in the drainage just downslope of the North and South Area Spray Fields (IHSSs 167.1 and 167.3). These samples will be collected within the stream at points that are conducive to the collection of sediment (Figures 7-4 and 7-6). The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. The samples will be collected according to SOP SW.6 and the SOPA to SOP SW.6.

One additional surface water station will be located on the intermittent stream north and downgradient of IHSS 167.3 (not shown on Figure 7-4 or 7-6). An additional surface water station is not necessary downgradient of the North Area Spray Field because site-wide surface water station SW-96 already exists. Samples will be collected according to SOPs SW.1, SW.2 and SW.8. The analytical program for these samples is described in subsection 7.3.

Stage 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of the North Area and South Area spray fields to monitor the saturated alluvium (Figure 7-6). Existing alluvial monitoring well B206789 already characterizes the groundwater downgradient of the Pond Area Spray Field. These wells will be located within the surface drainages that flow toward North Walnut Creek. It is possible due to the limited saturated thickness of the alluvium that there may be locations where there is no water or times of the year when the saturated thickness is zero. If this is the case, it may be necessary to relocate the wells or possibly install a vadose zone sampling device such as the BAT sampler to characterize the contaminant plumes in zones of limited water. The wells will be drilled according to SOP GT.2 and installed according to SOP GT.6 with the screen located in the alluvium just above the weathered bedrock. If a water bearing sandstone unit is found to be the first bedrock unit underlying the alluvium, an additional well will be completed in the weathered sandstone unit at that location. The wells will be developed according to SOP GW.2 and sampled according to SOPs GW.5 and GW.6 following development. The results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled on a quarterly basis for a minimum of one year.

7.2.8 IHSS 216.1 - East Area Spray Field

Stage 1 - Historical Data

As specified in the IAG, historical information regarding the use of the East Spray Field (IHSS 216.1) will be obtained and submitted to the EPA and CDH. The preliminary review of historical data performed for this work plan indicated that the East Spray Field only operated during 1989 and received water from Pond B-3 (see Section 2.0). Analyses of the Pond B-3 surface water from 1989 indicates that fairly low concentrations of radionuclides, metals, and organics were present.

Stage 2 - Surface Soil Samples and Soil Borings

Surface soil samples will be collected to a depth of 2 inches on a 200-foot grid over the entire site (Table 7-9 and Figure 7-3). Samples will be collected according to SOP 3.8. In addition, soil borings will be located on the same 200-foot grid as the surface soil samples. The borings will be drilled to a depth of 4 feet according to SOP GT.8. Samples will be taken continuously and will be composited from each 2-foot interval. The analytical program for these soil samples is described in Section 7.3.2. If contamination is noted, an alluvial groundwater monitoring well may be necessary to characterize the groundwater downgradient of the East Area Spray Field.

7.2.9 Ambient Air Monitoring Program

Three Hi-Vol air sampling devices will be installed near the North and South Walnut Creek drainages to monitor the air pathway from Operable Unit No. 6 (Figure 7-4). One will be located approximately 1,000 feet south of Pond B-4 (IHSS 142.8). The second air monitoring station will be placed approximately 1,000 feet south of Pond B-5 (IHSS 142.9) and the third will be located about 300 feet east of Pond B-5.

The data obtained from these stations, as well as the existing nearby air stations, will be used to evaluate the radioactive ambient emissions from this area. There are currently seven air monitoring stations (S-3, S-4, S-6, S-21, S-22, S-24, and S-36) near North and South Walnut creek drainages (Figure 7-4 and Attachment 1). The three proposed monitoring stations will be sampled in accordance with the Site-Wide Ambient Air Monitoring Program currently being conducted by EG&G at the Rocky Flats Plant. The operation and sampling procedures are briefly described below.

Air coming in contact with the Hi-Vol Ambient Air samples is forced through a filter material, trapping radioactive particulates and other airborne matter for subsequent analysis. Performance data from these RAAMP air samplers are collected by Environmental Monitoring and Assessment Technologists (EMAT) on a

TABLE 7-9

PHASE I INVESTIGATION
IHSS 216.1 - EAST AREA SPRAY FIELD

Activity	Purpose	Location	Number of Samples or Locations
Surface soil sampling	Characterize surface contamination	Entire site - 200 ft. grid	6
Soil borings	Characterize subsurface conditions and contamination to 4 ft.	Entire site - 200 ft. grid	6

weekly basis, and air filters are replaced every 2 weeks. Once a month, the two filters collected from each air monitoring station are composited, and one sample from each air monitoring station is sent to Radiological Health Labs (Building 123) at the Plant for analysis. Detailed procedures describing the air sampler operations, filter exchange, filter preparation for analysis, RAAMP documentation, and reporting requirements are contained in SOP AP.13. These air samples will be analyzed according to the procedures outlined in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP). The samples will be analyzed for plutonium, the same analyte as is analyzed in the site-wide program . The analytical program for the site-wide Ambient Air Program is expected to be expanded in the near future to include other radionuclides, at which time the analytical program for the three proposed OU6 air stations will also be increased.

7.3 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected during the Phase I investigation. This section discusses sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation.

7.3.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the Rocky Flats Environmental Database System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "WC" for Woodward-Clyde). One sample number will be required for each sample generated, including QA/QC samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the database. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU6. Boring numbers will be developed independently of the sample number for a given boring. Specific sample location numbers are not assigned at this time, pending the results of the aerial photograph analysis and review of existing data.

7.3.2 Analytical Requirements

Generally, samples from the Phase I RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Nitrate
- Target Analyte List (TAL) metals
- Uranium 233/234, 235 and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta
- Tritium
- Total Dissolved Chromium (water only)
- Total organic carbon (TOC)
- Targeted Compound List (TCL) volatile organics
- TCL semivolatile organics
- TCL pesticides/PCBs
- CO_3, HCO_3, Cl, SO_4, NO_3 (water only)

The specific analytes in the groups listed above and their detection/quantitation limits are contained in Table 7-10. The specific Phase I analytical programs for each IHSS are contained in Table 7-11. Both filtered and unfiltered samples, surface water and groundwater samples will be analyzed at each location.

The analytical program for each media at every IHSS is summarized in Table 7-11. This analytical program for each IHSS was developed in the IAG based on the type of waste suspected to be present at each site. The specific analytes and detection/quantitation limit are specified in the IAG by reference to CLP (Contract Laboratory Program) analyses. The GRRASP (EG&G 1990d) provides a listing of CLP analytes and limits that will be used for this Phase I RFI/RI. These analytes and limits are presented in Table 7-10. The program shown in Table 7-11 should address the bulk of chemicals and compounds that were handled or suspected to be present at OU6 and enable detection of soil, sediment, surface water, and groundwater contamination, if present. Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present in Walnut Creek. Metals were handled at OU6; however, details are not well known. Therefore, all of the TAL metals plus other metals known to have been found on site have been selected for Phase I analysis.

Uranium is likely to have been a constituent of the wastes at OU6. The isotopes U-233, U-234, U-235 and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and is found at the Rocky Flats Plant. Therefore, plutonium and americium have been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium, strontium, and cesium are also included in the analytical program.

TABLE 7-10

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	DETECTION LIMITS*	
TARGET ANALYTE LIST - METALS	Water (µg/l)	Soil/Sediment (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Lithium	100	20
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Molybdenum	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium	200	40
Thallium	10	2.0
Tin	200	40
Vanadium	50	10.0
Zinc	20	4.0
TOTAL ORGANIC CARBON	1	1
	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES	Water (µg/l)	Soil/Sediment (µg/kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5

TABLE 7-10
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUNDS LIST - VOLATILES (Continued)	QUANTITATION LIMITS* Water (μg/l)	Soil/Sediment (μg/kg)
total 1,2-Dichloroethene	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
trans-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
cis-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		

TARGET COMPOUNDS LIST - SEMIVOLATILES	QUANTITATION LIMITS* Water (μg/l)	Soil/Sediment (μg/kg)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-di-n-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 7-10
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

	QUANTITATION LIMITS*	
TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water (µg/l)	Soil/Sediment (µg/kg)
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330

TABLE 7-10
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water (μg/l)	Soil/Sediment (μg/kg)
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

TARGET COMPOUND LIST - PESTICIDES/PCBS	QUANTITATION LIMITS*	
	Water μg/l	Soil/Sediment μg/kg
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDD	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5	80.0
gamma-Chlordane	0.5	80.0
Toxaphene	1.0	160.0
Aroclor-1016	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

TABLE 7-10
(Concluded)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

	REQUIRED DETECTION LIMITS*	
RADIONUCLIDES	Water (pCi/ℓ)	Soil/Sediment (pCi/g)
Gross Alpha	2	4 dry
Gross Beta	4	10 dry
Uranium 233+234, 235, and 238 (each species)	0.6	0.3 dry
Americium 241	0.01	0.02 dry
Plutonium 239+240	0.01	0.03 dry
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.1 dry
Strontium 89+90	1	1 dry

	DETECTION LIMITS*
Parameters Exclusively for Groundwater Samples	Water (mg/ℓ)
ANIONS	
Carbonate	10
Bicarbonate	10
Chloride	5
Sulfate	5
Nitrate as N	5
FIELD PARAMETERS	
pH	0.1 pH unit
Specific Conductance	1
Temperature	
Dissolved Oxygen	0.5
Barometric Pressure	
INDICATORS	
Total Dissolved Solids	5

* Detection and quantitation limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

TABLE 7-11
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	Total U	Total Cr	Be	H3	Nitrate	Gross α	Gross β	U 233/234	U 235	U 238	Pu 239/240	Am 241	Cs 137
141	Surface samples on 25' grid	Soil		X	X		X	X	X	X	X	X	X	X	
	Well downgradient of unit	Water	X					X	X				X	X	
142	Sediment samples	Seds.		X	X	X	X	X	X	X	X	X	X	X	X
	Dry sediment samples	Seds.		X	X	X	X	X	X	X	X	X	X	X	X
	Water samples	Water		X	X	X	X	X	X	X	X	X	X	X	X
	Wells downgradient of A-4 and B-5 including the four Bedrock Wells in North Walnut Creek	Water		X	X	X	X	X	X	X	X	X	X	X	X
143	Surface samples	Soil		X	X	X	X	X	X	X	X	X	X	X	
	Core Samples on 20' grid	Soil		X	X	X	X	X	X	X	X	X	X	X	
	Well downgradient of unit	Water		X	X	X	X	X	X	X	X	X	X	X	
156	Surface samples	Soil						X	X	X	X	X	X	X	
	Borings	Soil						X	X	X	X	X	X	X	
	Well within unit	Water						X	X	X	X	X	X	X	
165	Surface samples from transect locations	Soil	X		X			X	X	X	X	X	X	X	
	Borings to confirm soil gas	Soil													
	Borings transecting plumes grabs from 2' intervals 6' composites	Soil			X			X	X	X	X	X	X	X	
	Wells within the site	Water						X	X						
	Sediment sample	Seds.		X	X	X	X	X	X	X	X	X	X	X	X
166	Borings along each trench grabs from 2' intervals 6' composites	Soil						X	X	X	X	X	X	X	
	Well downgradient of the trenches and the Bedrock Well located in unnamed tributary of North Walnut Creek	Water						X	X						
167	Surface and core samples on 100' grid	Soil						X	X	X	X	X	X	X	
	Surface water sample	Water		X	X	X	X	X	X	X	X	X	X	X	X
	Wells downgradient of units	Water				X	X						X	X	
216	Surface and core samples	Soil				X		X	X	X	X	X	X	X	

TABLE 7-11 (Continued)
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	TAL Metals	TOC	TCL Vols	TCL Semi	TCL Pests	Filtered U	Filtered Pu 239/240	Filtered Cs 239/240	Filtered Sr 89/90	Filtered Am 241	Filtered TAL Met	Filtered Anions TDS
141	Surface samples on 25' grid	Soil	X				X*							
	Well downgradient of unit	Water	X		X	X								
142	Sediment samples	Seds.	X	X	X	X	X							
	Dry sediment samples	Seds.	X			X	X							
	Water samples	Water	X		X	X		X	X	X	X	X	X	X
	Wells downgradient of A-4 and B-5 including the 4 bedrock wells in North Walnut Creek	Water	X		X	X		X	X	X	X	X	X	X
143	Surface samples	Soil	X	X		X	X							
	Core Samples on 20' grid	Soil	X	X	X	X	X							
	Well downgradient of unit	Water	X	X	X	X	X							
156	Surface samples	Soil	X	X										
	Borings	Soil	X											X
	Well within unit	Water	X					X	X			X	X	
165	Surface samples from transect locations	Soil	X	X			X							
	Borings to confirm soil gas	Soil			X	X								
	Borings transecting plumes grabs from 2' intervals 6' composites	Soil	X		X	X								
	Sediment sample	Seds.	X	X	X	X	X							
	Wells within the site	Water	X		X	X	X							
166	Borings along each trench grabs from 2' intervals 6' composites	Soil	X		X							X		
	Well downgradient of trench	Water	X		X	X	X							
167	Surface and core samples on 100' grid	Soil	X	X										
	Surface water sample	Water	X		X	X	X	X	X	X	X	X	X	X
	Wells downgradient of units	Water	X		X		X	X	X					
216	Surface and core samples	Soil	X	X										

* Six randomly chosen surface soil samples will be analyzed for TCL pesticide/PCBs.

Volatile and semivolatile organics may have been handled at OU6 in small quantities. The specific compounds used are unknown; therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses. TCL pesticides/PCBs and TOC have been included to provide data for the environmental evaluation.

The analytical parameters for the soil gas survey at IHSS 165 are carbon tetrachloride, trichloroethene (TCE), dichloromethane, acetone, 2-butanone, tetrachloroethene (PCE), 1,2-dichloroethane (DCA), chloroform and toluene. Detection limits proposed for these parameters during the soil gas survey are listed in Table 7-12.

7.3.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments. The water matrices for analysis will include surface water and groundwater. Tables 7-13 and 7-14 list analytical parameters of interest in OU6 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

7.3.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP FO.14.

7.3.5 Data Reporting Requirements

Field data will be input into the RFEDS environmental database using a remote data entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed QC process based on SOP FO.14 to be generated by EG&G.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate the timely reporting of the information.

TABLE 7-12

PHASE I INVESTIGATION
SOIL GAS PARAMETERS AND
PROPOSED DETECTION LIMITS

IHSS-165 Triangle Area

Volatiles	Detection Limit
methylene cloride	1 μg/l
acetone	1 μg/l
2-butanone	1 μg/l
chloroform	1 μg/l
carbon tetrachloride	1 μg/l
toluene	1 μg/l
PCE	1 μg/l
TCE	1 μg/l
1,2 DCA	1 μg/l

NOTE: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

TABLE 7-13

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER SAMPLES

Parameter	Container	Preservative	Holding Time
Liquid - Low to Medium Concentration Samples			
Organic Compounds:			
Purgeable Organics (VOCs)	2 x 40-mL VOA vials with teflon lined septum lids	Cool, 4°C[a] with HCl to pH<2	7 days 14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 4-L amber[b] glass bottle	Cool, 4°C[a]	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1-L polyethylene bottle	Nitric acid pH<2; Cool, 4°C	180 days[c]
Cyanide	1 x 1-L polyethylene bottle	Sodium hydroxide[d] pH>12; Cool, 4°C	14 days
Anions	1 x 1-L polyethylene bottles	Cool, 4°C	14 days
Sulfide	1 x 1-L polyethylene bottle	1 mL-zinc acetate sodium hydroxide to pH>9; Cool, 4°C	7 days
Liquid - Low to Medium Concentration Samples			
Nitrate	1 x 1-L polyethylene bottle	Cool, 4°C	48 hours
Total Dissolved Solids (TDS)	1 x 1-L polyethylene bottle	Cool, 4°C	48 hours
Radionuclides (Full Suite)	12 x 1-L polyethylene bottle	Nitric acid pH<2	180 days

[a] Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine

[b] Container requirement is for any or all of the parameters given.

[c] Holding time for mercury is 28 days.

[d] Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each L of sample volume.

TABLE 7-14

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
Soil or Sediment Samples - Low to Medium Concentration			
Organic Compounds:			
Purgeable Organics (VOCs)	1 x 4-oz wide-mouth teflon lined glass vials	Cool, 4°C	14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 8-oz wide-mouth teflon lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8-oz wide-mouth glass jar	Cool, 4°C	180 days[1]
Cyanide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8-oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 1-L wide-mouth glass jar	None	45 days

[1]Holding time for mercury is 28 days.

This data will also be delivered to EG&G on 3.5-inch diskettes. Computer hardware and software requirements for contractors using government supplied equipment will be supplied by EG&G. Computer and data security will also follow acceptable procedures outlined by EG&G.

7.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the ER Project Manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their applications are discussed below. The frequency for QC samples to be collected and analyzed is provided in Table 7-15.

Duplicate samples will be collected by the sampling team and will be used as a measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (subsection 7.3.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation technique. As indicated by Table 7-15, these QC samples are applicable only to samples requiring chemical preservation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on nondedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample containers. Equipment rinsate blanks are applicable to all analyses for water and soil samples as indicated in Table 7-15.

Trip blanks consisting of deionized water will be prepared by the laboratory technician and will accompany each shipment of water samples for volatile organic analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of volatile organics or any problems associated with the shipment, handling, or storage of the samples.

Procedures for monitoring field QC are given in the site-wide Quality Assurance Project Plan (QAPjP).

TABLE 7-15

FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics (Volatiles)	NR	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required

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ATTACHMENT 1

HISTORICAL AIR QUALITY DATA FOR OU6

RAAMP Data for OU-6

OU-6 PLUTONIUM 239 CONCENTRATIONS PRESENTED IN pCi/m3

	1986	1987	1988	1989	1990		
	Station-21	Station-21	Station-21	Station-21	Station-21		
JANUARY	0.000008	0.000014	0.000169	0.000060	0.000011		
FEBRUARY	0.000018	0.000036	0.000016	0.000007	0.000012		
MARCH	0.000005	0.000010	0.000055	N/A	0.000005		
APRIL	0.000009	0.000018	0.000190	0.000023	0.000004		
MAY	0.000018	0.000023	0.000036	0.000009	0.000006		
JUNE	0.000009	0.000030	0.000072	0.000011	0.000018		
JULY	0.000011	0.000054	0.000016	0.000018	0.000004		
AUGUST	0.000010	0.000021	0.000020	0.000008	0.000004		
SEPTEMBER	0.000007	0.000013	0.000048	N/A	0.000004		
OCTOBER	0.000009	0.000030	0.000072	0.000013	0.000013		
NOVEMBER	0.000007	0.000032	0.000032	N/A	0.000012		
DECEMBER	0.000006	0.000051	N/A	N/A	0.000015		
Annual Ave.	0.000010	0.000028	0.000066	0.000019	0.000009		
Max. Value	0.000018	0.000054	0.000190	0.000060	0.000018		

	1990						
	Station-03	Station-04	Station-06	Station-22	Station-24	Station-33	Station-36
JANUARY	0.000171	0.000181	0.000043	0.000001	0.000003	0.000002	0.000001
FEBRUARY	0.000000	0.000013	0.000039	0.000006	0.000002	0.000002	0.000003
MARCH	0.000004	0.000009	0.000013	0.000005	0.000002	N/A	N/A
APRIL	0.000000	0.000004	0.000061	0.000003	0.000003	N/A	N/A
MAY	0.000000	0.000007	0.000068	0.000004	0.000004	0.000001	0.000001
JUNE	0.000002	0.000009	0.000066	0.000003	0.000003	0.000001	0.000002
JULY	0.000002	0.000007	0.000026	0.000007	0.000001	0.000001	0.000001
AUGUST	0.000003	0.000006	0.000041	0.000001	0.000001	0.000001	0.000001
SEPTEMBER	0.000003	0.000006	0.000482	0.000003	0.000001	0.000001	0.000002
OCTOBER	0.000002	0.000007	0.000279	0.000003	0.000001	0.000002	0.000002
NOVEMBER	0.000002	0.000014	N/A	0.000009	0.000010	0.000001	0.000001
DECEMBER	0.000003	0.000001	N/A	0.000003	-0.000002	0.000001	0.000001
Annual Ave.	0.000016	0.000022	0.000112	0.000004	0.000002	0.000001	0.000002
Max. Value	0.000171	0.000181	0.000482	0.000009	0.000010	0.000002	0.000003

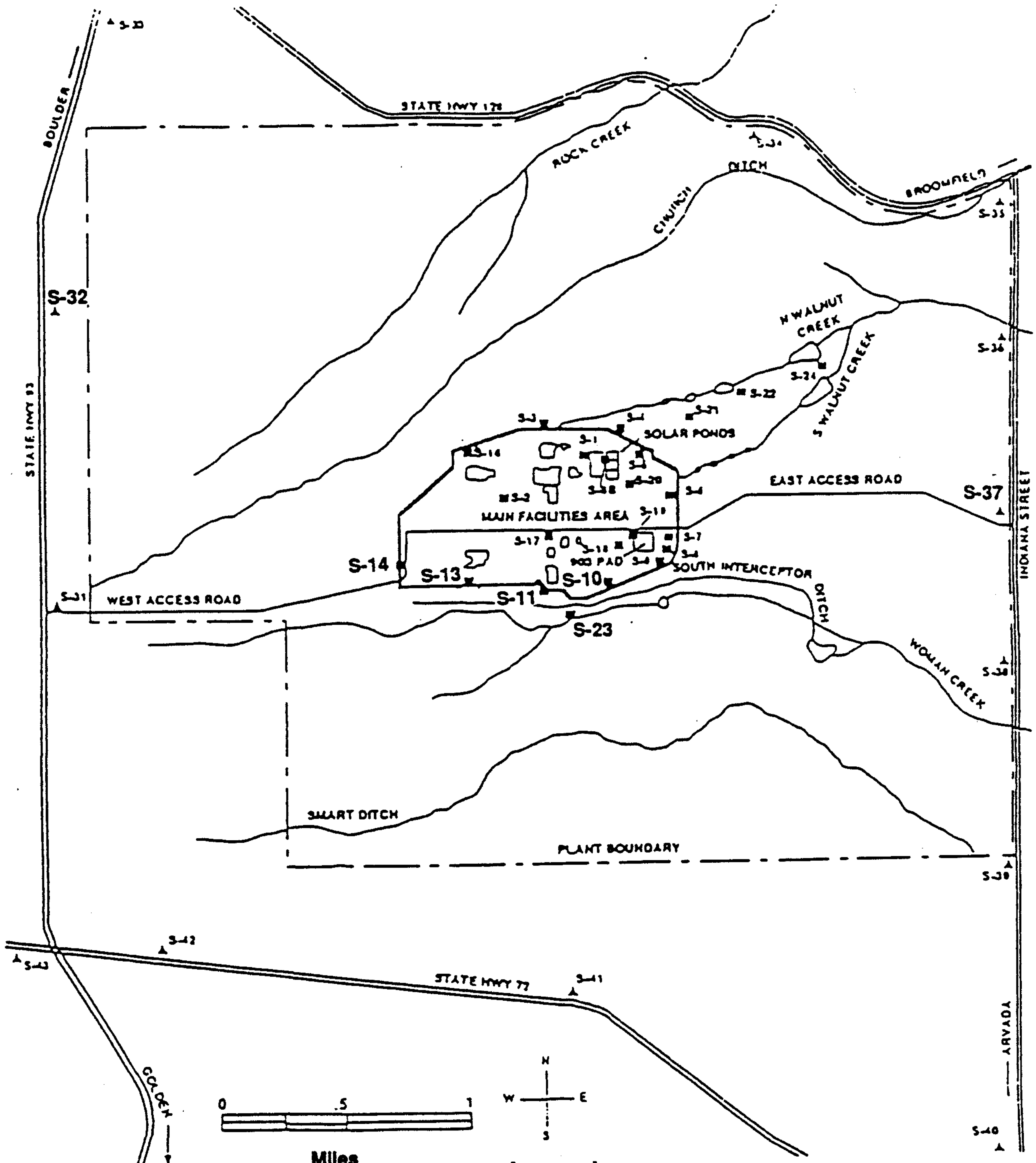
RAAMP Data for OU-6

Prior to January 1990 the biweekly filters from most onsite samplers (including the ones designated for OU-6 support) were analyzed for total long-lived alpha activity only. If results exceeded the Rocky Flats Plant (RFP) guideline of $10x10^{-16}$ μCi/ml, specific plutonium analysis was performed. Data collected at ambient stations 03, 04, 06, 22, 24, 33, and 36 during 1986 through 1989 did not exceed this screening value, therefore; no plutonium specific analysis for performed.

Selected on-site sampling locations that were in areas where there was a potential or history of elevated concentrations were routinely analyzed for specific isotopes. A five-year plutonium specific data-set is available for station No. 21 and is presented above.

N/A = Not available in database

FIGURE 13-3
ONSITE AND PERIMETER SAMPLER LOCATIONS



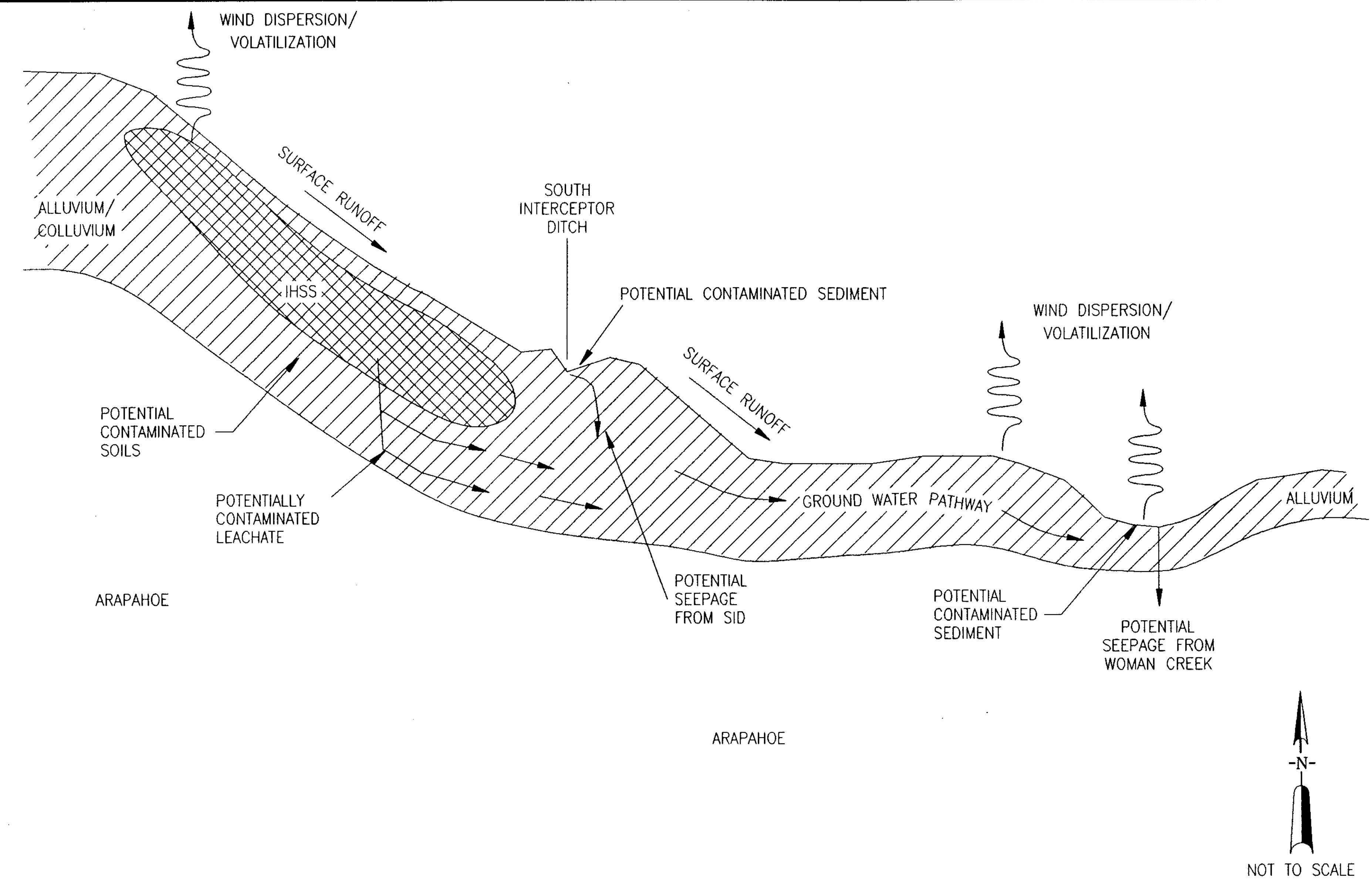
Miles
Approximate Scale

Legend

Note: all samplers analyzed for Pu

- ▪ Onsite Air Samplers
- ▲ Perimeter Air Samplers within 2 to 4 miles of RFP

R33165.PJ-121691

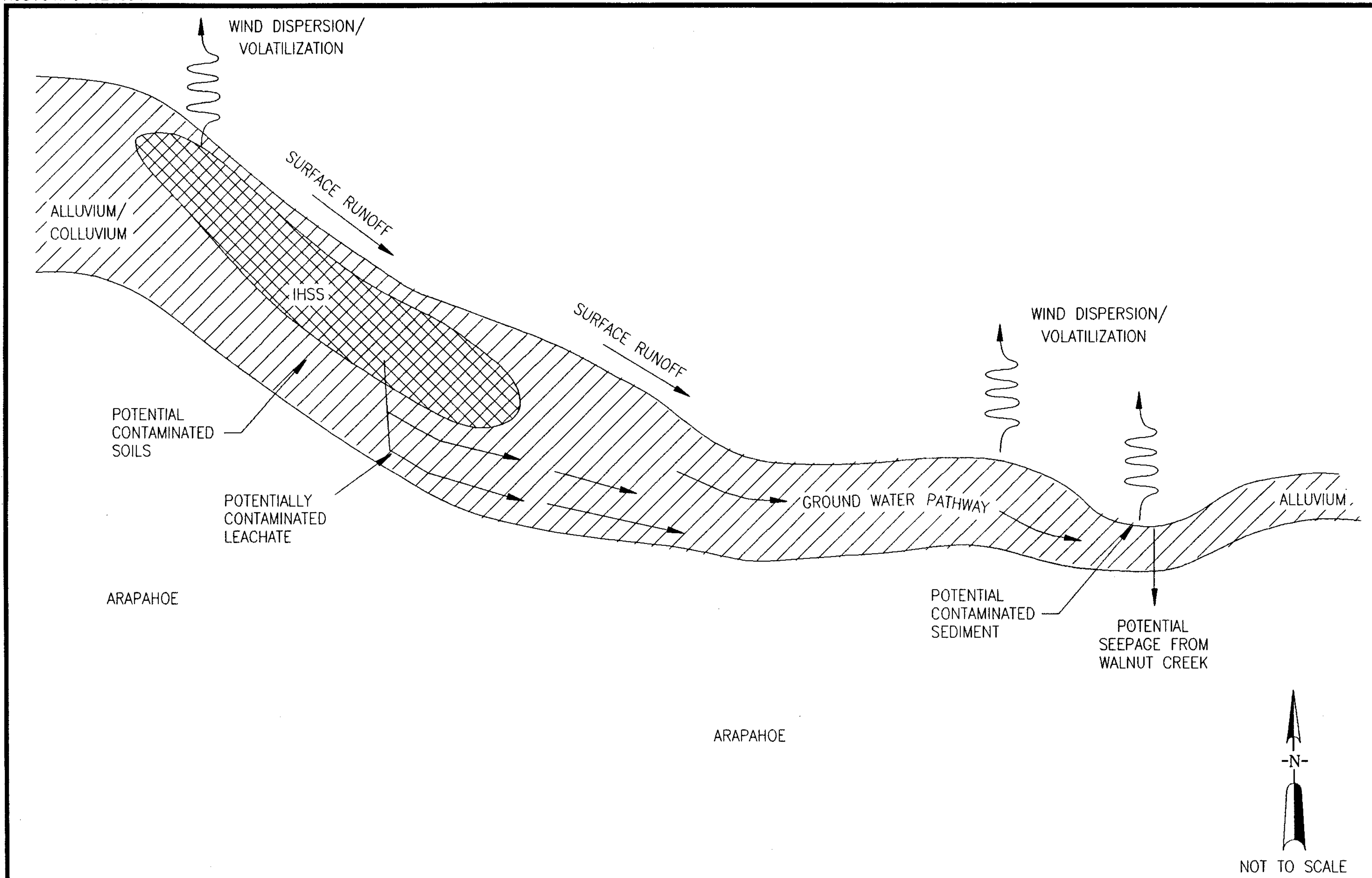


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

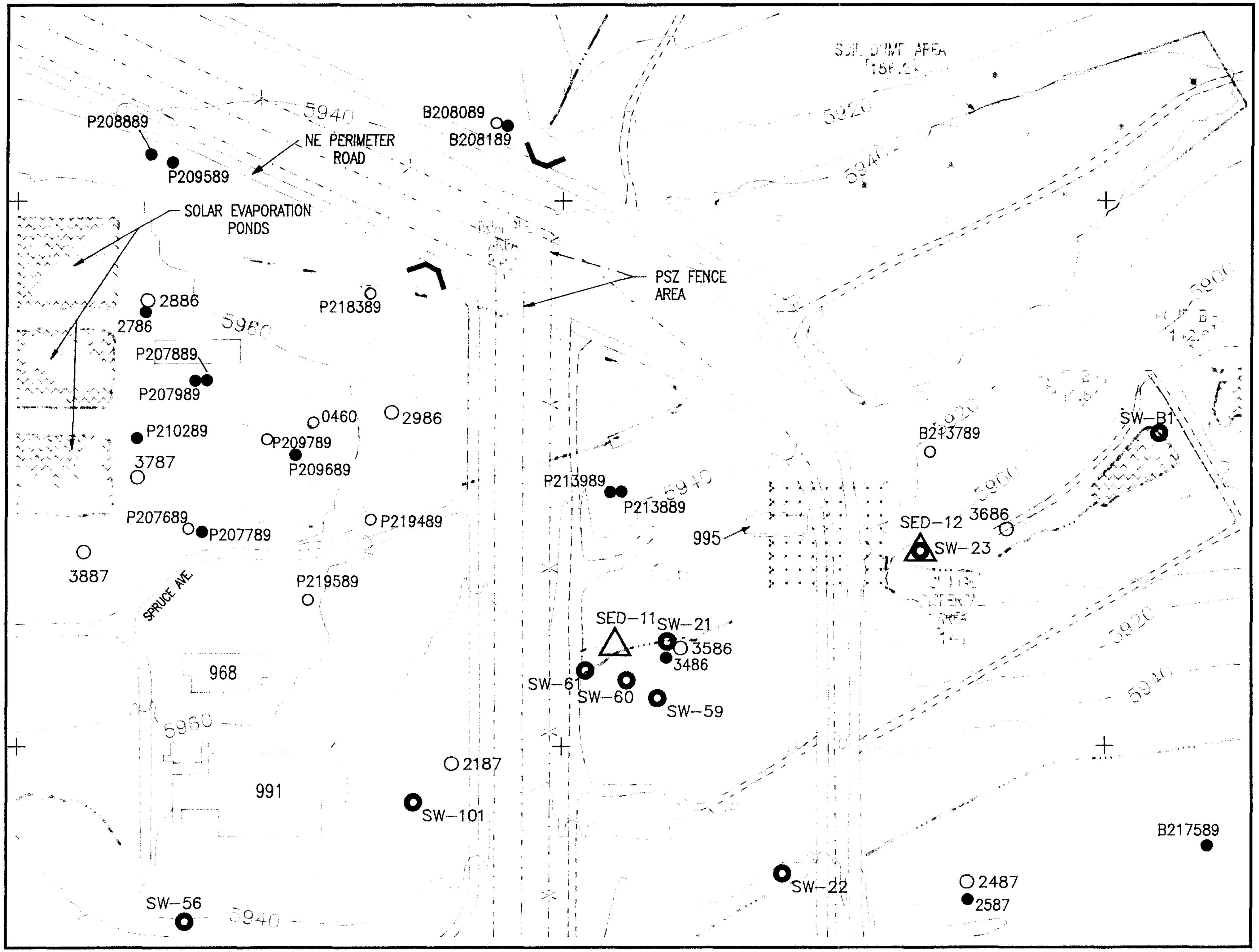
CONTAMINANT MIGRATION PATHWAYS
FOR OPERABLE UNIT 5

FIGURE
1

R33164.PJ-121691



U.S. DEPARTMENT OF ENERGY Rocky Flats Plant Golden, Colorado	CONTAMINANT MIGRATION PATHWAYS FOR OPERABLE UNIT 6	FIGURE 2-17



N

SCALE:

EXPLANATION

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
3087	EXISTING BEDROCK GROUNDWATER MONITORING WELL
	DIRT ROAD
	INTERMITTENT STREAM
968	ROCKY FLATS BLDG. NO.
	PROPOSED SOIL GAS SURVEY LOCATION[1]
	PROPOSED WELL LOCATION[1]
	PROPOSED SURFACE SAMPLING AND RADIATION SURVEY LOCATION[1]
	PROPOSED BORING AND SURFACE SAMPLING LOCATION[1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

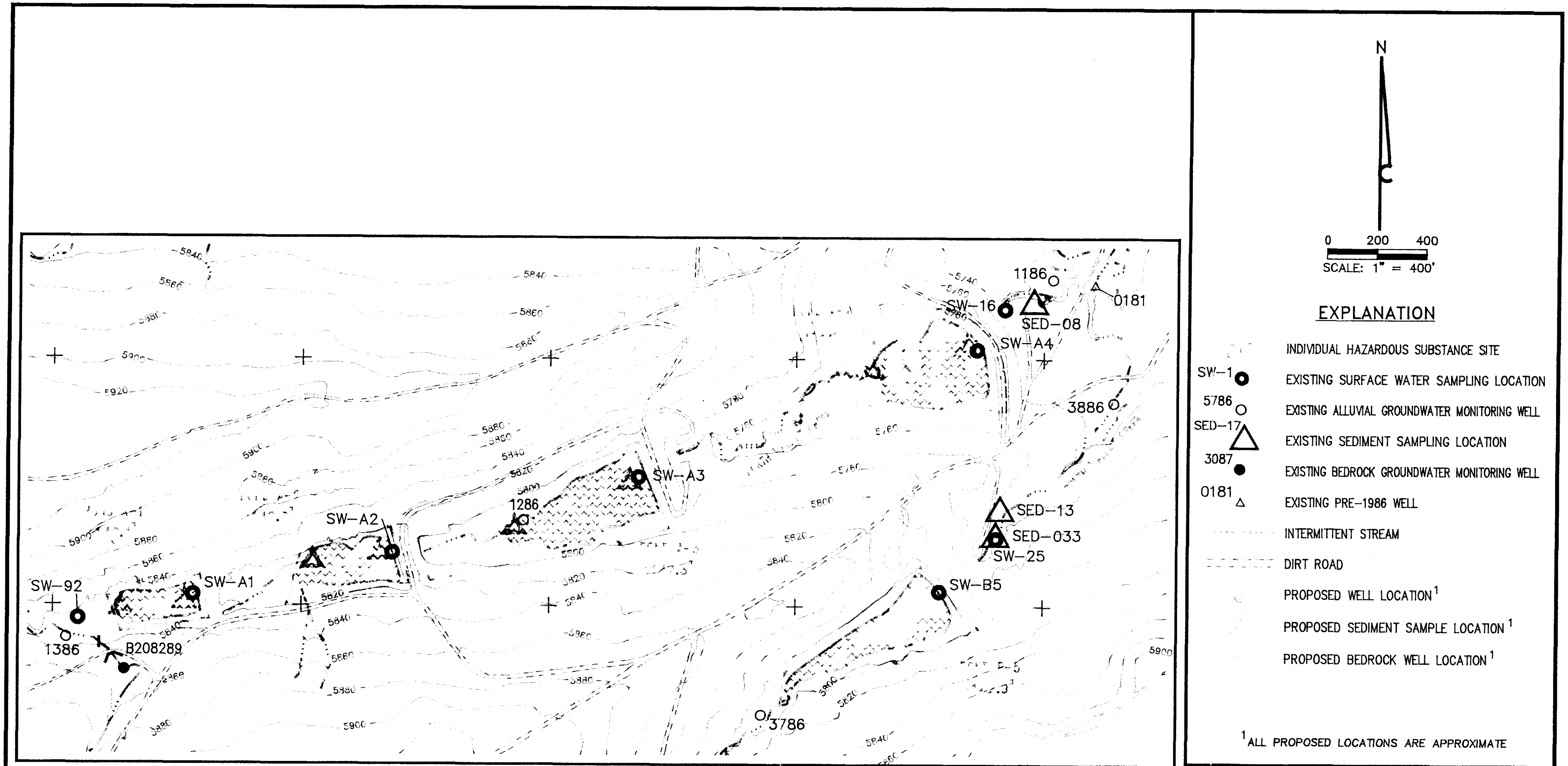
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING AND WELL LOCATIONS
IHSS 141 SLUDGE DISPERSAL
IHSS 165 TRIANGLE AREA
IHSS 156.2 SOIL DUMP AREA

REV. AUGUST 1991
APRIL 1991

FIGURE 7-1



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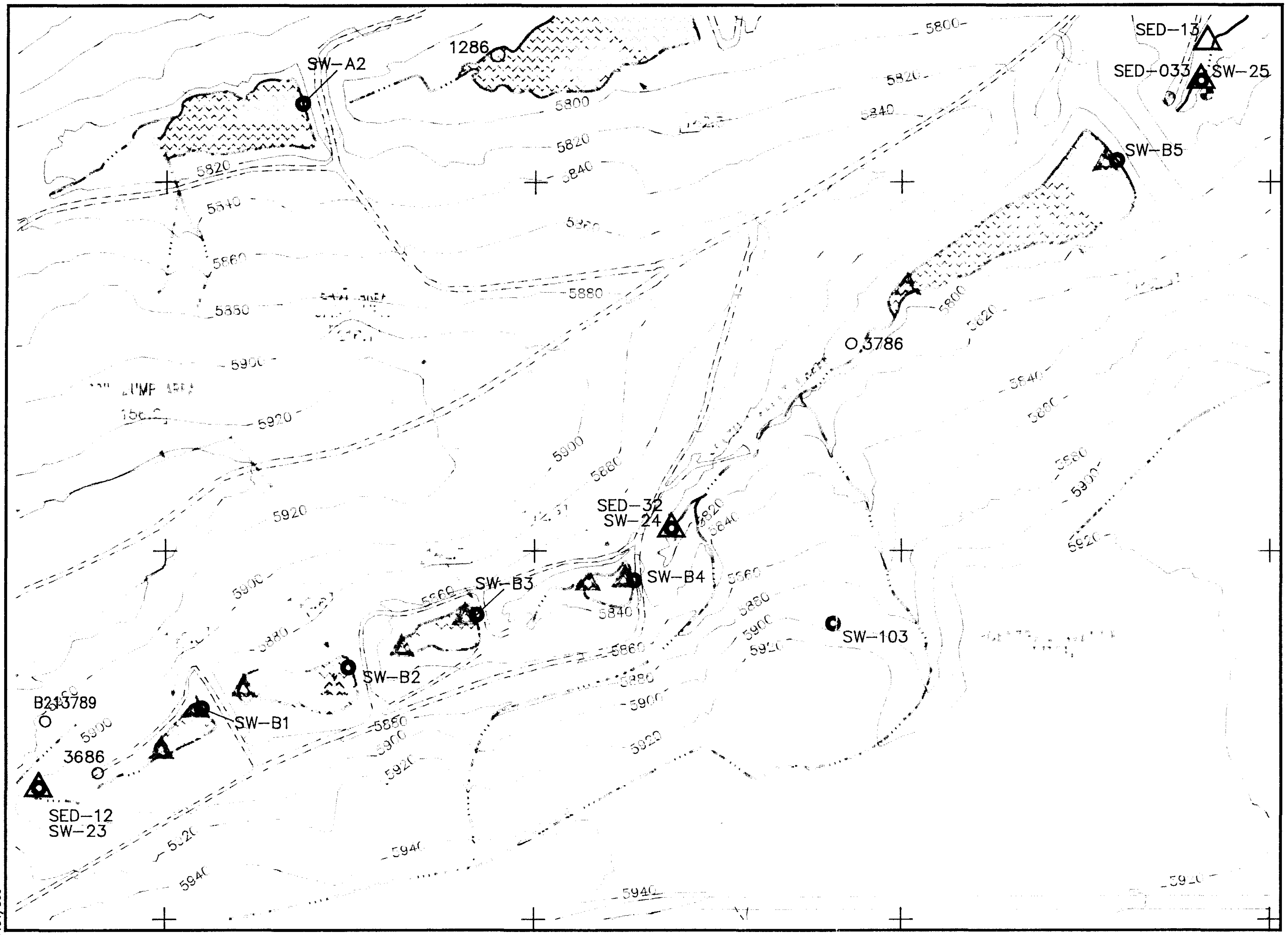
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSSs 142.1-4
A-SERIES DETENTION PONDS
ALONG NORTH WALNUT CREEK

FIGURE 7-2

REV. AUGUST 1991
APRIL 1991

R33W064.MB121191/400



N

0 150 300

SCALE: 1" = 300'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL

SED-17 EXISTING SEDIMENT SAMPLING LOCATION

INTERMITTENT STREAM

DIRT ROAD

968 ROCKY FLATS BLDG. NO.

PROPOSED WELL LOCATION [1]

PROPOSED BORING AND SURFACE SAMPLE [1] LOCATION

PROPOSED SEDIMENT SAMPLE LOCATION [1,2]

PROPOSED BEDROCK WELL LOCATION [1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

[2] THREE OTHER LOCATIONS IN EACH POND WILL BE SELECTED AT RANDOM

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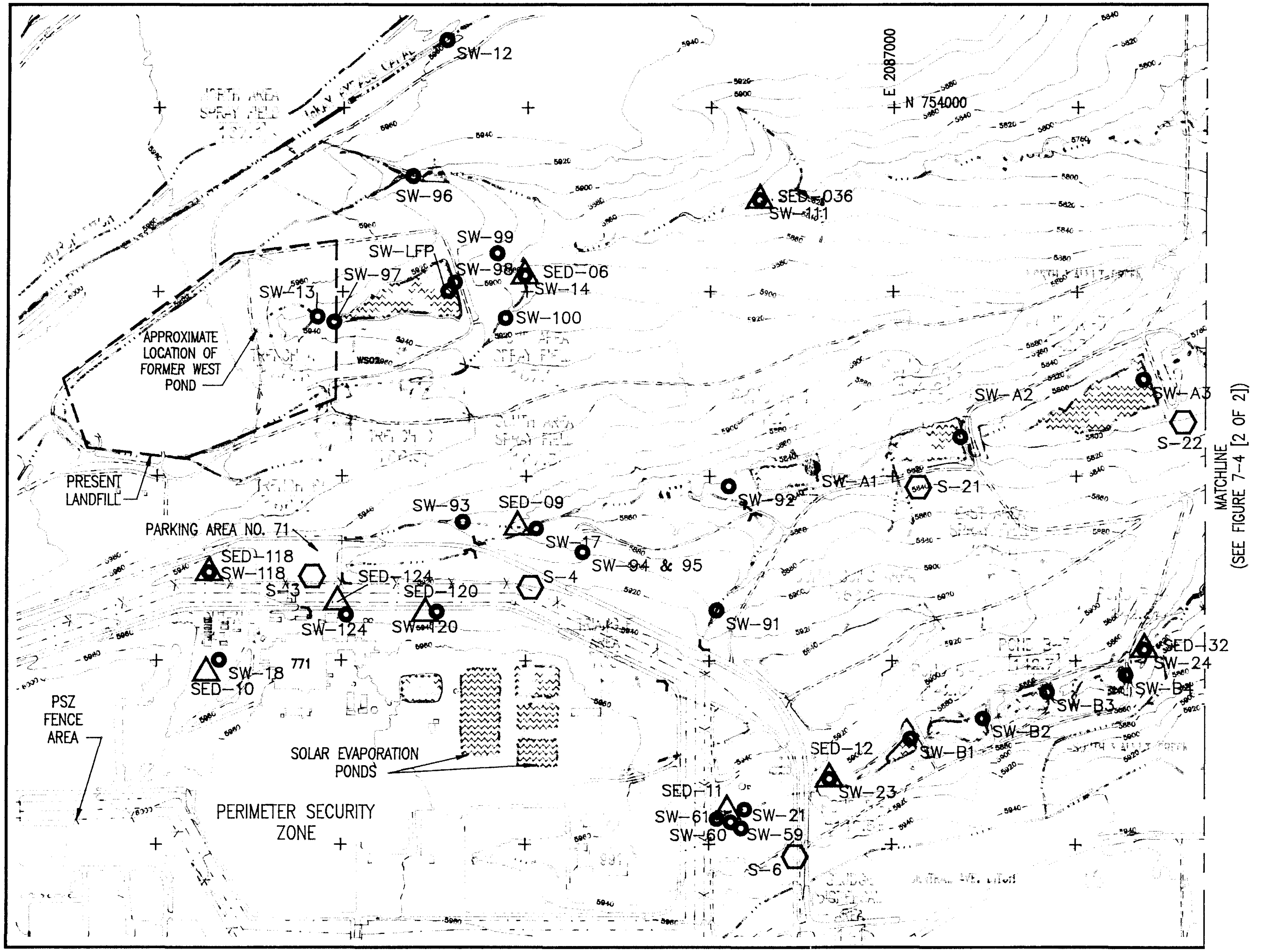
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSSs 142.5-9
B-SERIES DETENTION PONDS
ALONG SOUTH WALNUT CREEK
IHSS 216.1 EAST AREA SPRAY FIELD

REV. AUGUST 1991
APRIL 1991

FIGURE 7-3



EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

SED-17 EXISTING SEDIMENT SAMPLE LOCATION

S-22 EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

PERIMETER SECURITY ZONE

DIRT ROAD

PROPOSED SEDIMENT SAMPLE LOCATION [1]

PROPOSED BEDROCK WELL LOCATION [1]

PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION [1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

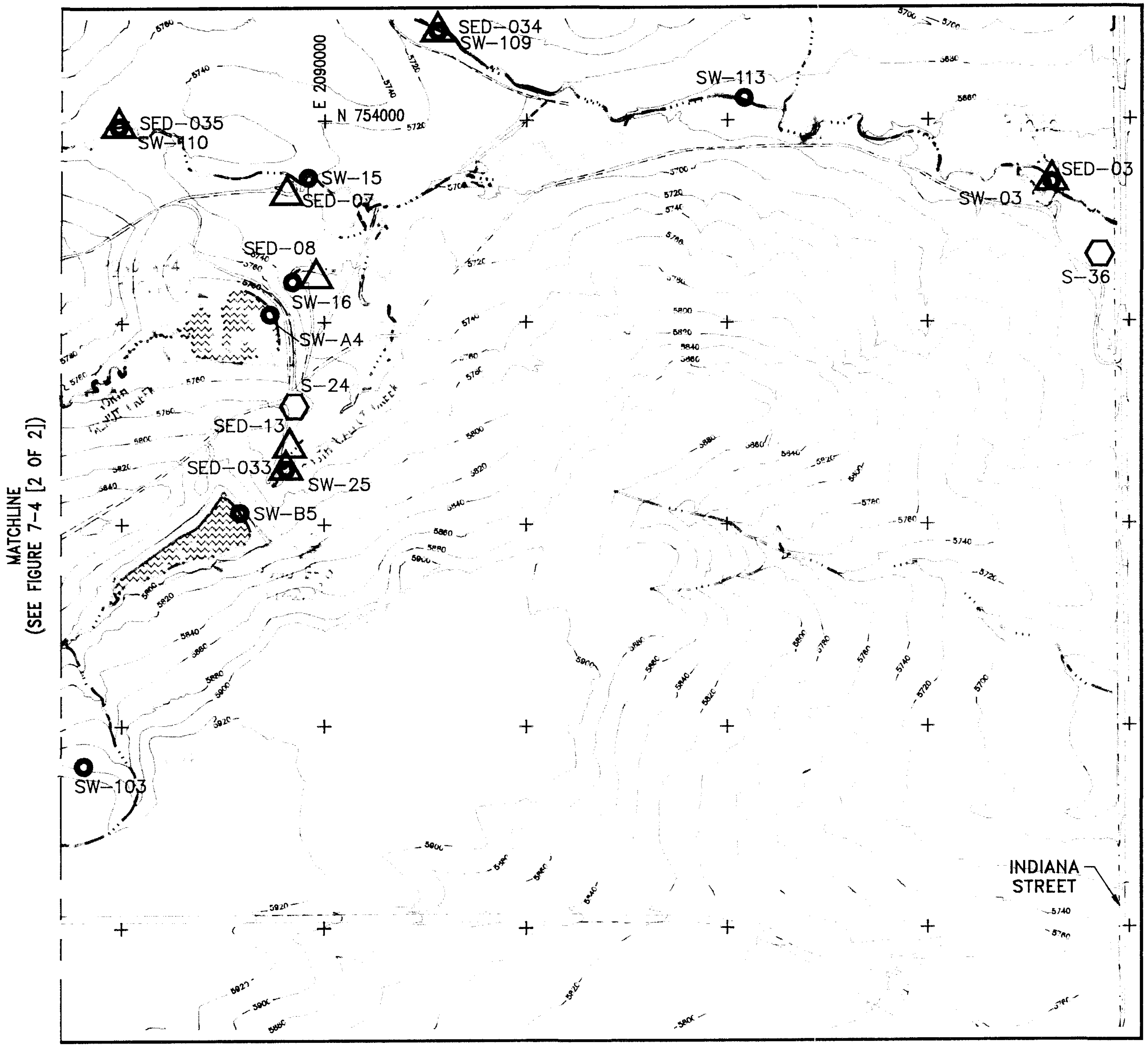
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SEDIMENT SAMPLING SITES, AIR MONITORING STATIONS, AND BEDROCK WELLS ON NORTH & SOUTH WALNUT CREEKS

REV. AUGUST 1991
APRIL 1991

FIGURE 7-4 (1 OF 2)

R33M066.MB121191/600



R33M067.MB121191/600

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 6

IHSS REFERENCE NUMBER

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

SED-17 EXISTING SEDIMENT SAMPLE LOCATION

S-22 EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

PERIMETER SECURITY ZONE

DIRT ROAD

PROPOSED SEDIMENT SAMPLE LOCATION [1]

PROPOSED BEDROCK WELL LOCATION [1]

PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION [1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

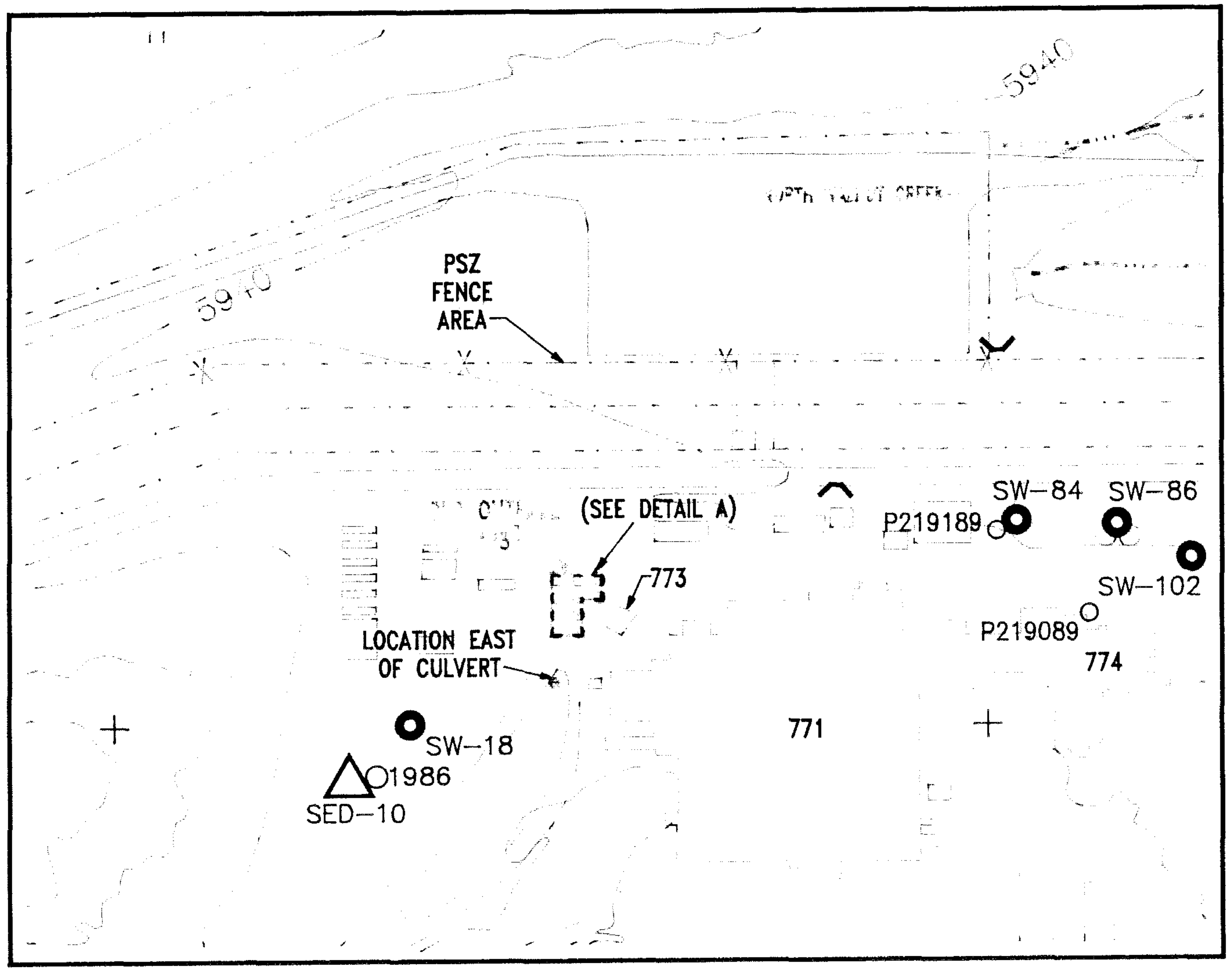
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

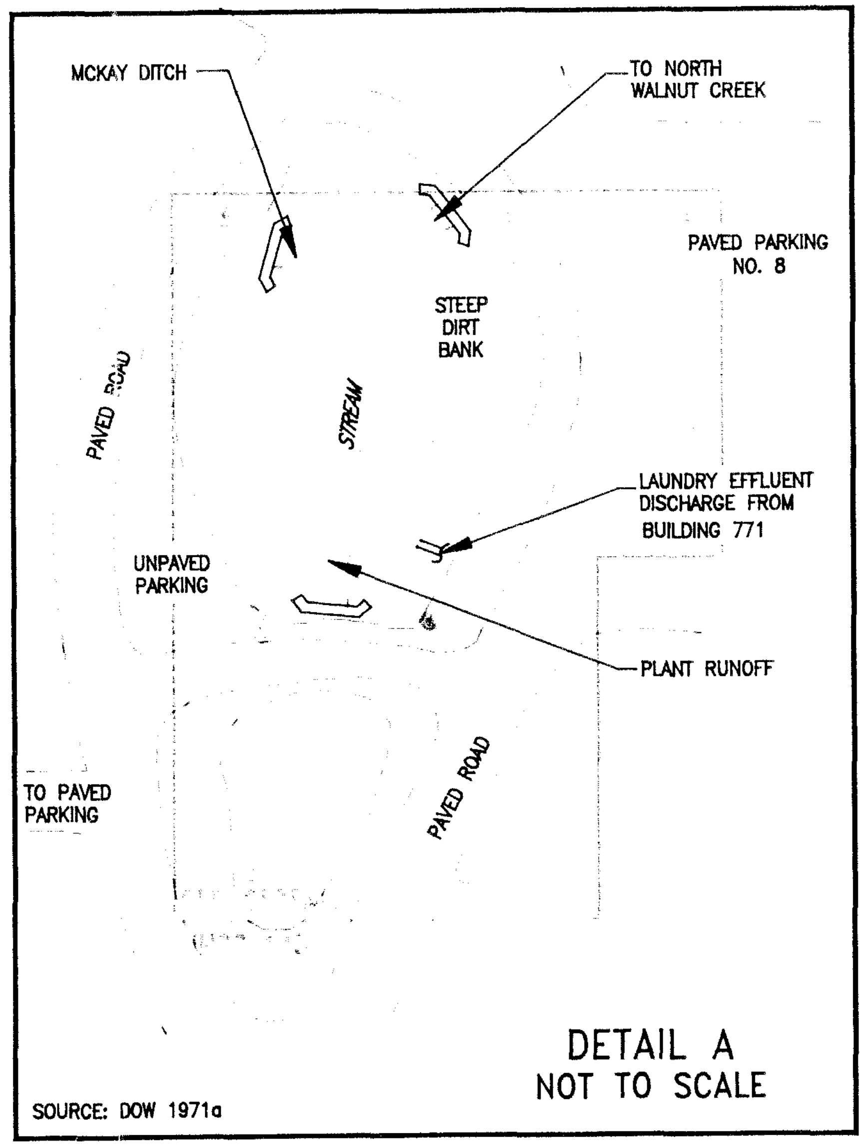
OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SEDIMENT SAMPLING SITES, AIR MONITORING STATIONS, AND BEDROCK WELLS ON NORTH & SOUTH WALNUT CREEKS

FIGURE 7-4 (2 OF 2)

REV. AUGUST 1991
APRIL 1991





N

0 100 200

SCALE: 1" = 200'

EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL

SED-17 EXISTING SEDIMENT SAMPLING LOCATION

INTERMITTENT STREAM

DIRT ROAD

968 ROCKY FLATS BLDG. NO.

PROPOSED SOIL BORING LOCATION[1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

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OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING LOCATIONS
IHSS 143 OLD OUTFALL AREA

FIGURE 7-5

REV. DECEMBER 1991
APRIL 1991

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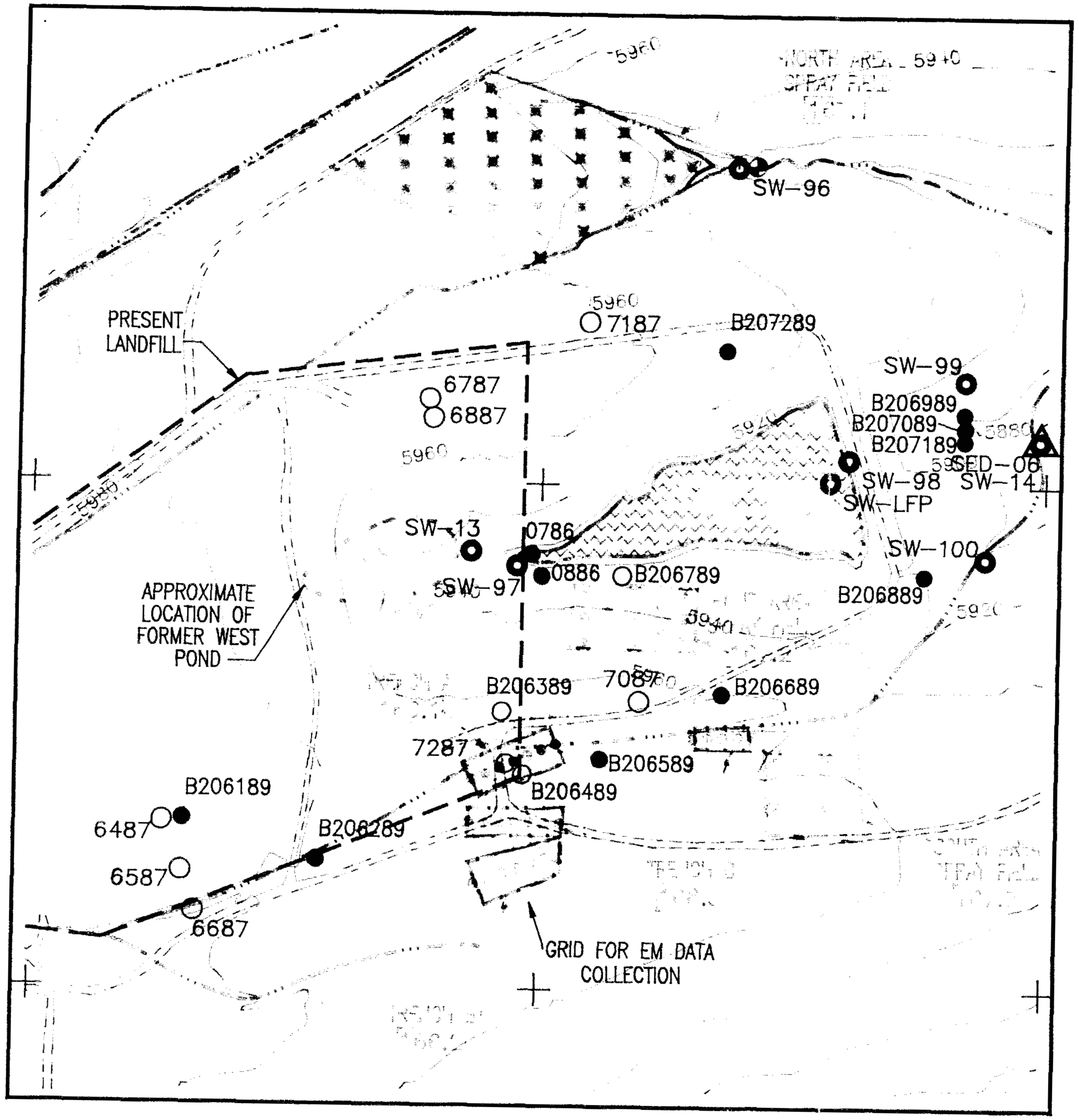

EXPLANATION

- INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SW-1 EXISTING SURFACE WATER SAMPLING LOCATION
- 5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
- SED-17 EXISTING SEDIMENT SAMPLING LOCATION
- 3087 EXISTING BEDROCK GROUNDWATER MONITORING WELL
- INTERMITTENT STREAM
- DIRT ROAD
- PROPOSED SOIL BORING LOCATION[1]
- PROPOSED WELL LOCATION[1]
- PROPOSED BORING AND SURFACE SAMPLE LOCATION[1]
- PROPOSED ELECTROMAGNETIC SURVEY LINE LOCATION[1]

[1] ALL PROPOSED LOCATIONS ARE APPROXIMATE

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OPERABLE UNIT 6
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS
IHSSs 166.1-3, TRENCHES A, B, & C
IHSSs 167.1-3 NORTH AREA,
POND AREA AND SOUTH AREA

FIGURE 7-6

REV. AUGUST 1991
APRIL 1991

R33M069.121191/300